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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

The Barking Super-Power Station.

The British Steam Railway Locomotive from 1825 to 1924—No. 21.

Steam Nozzle Research.

The Problem of Professional Status.

Railway Steam Car for New Zealand.

The Iron and Steel Institute—Annual Meeting—No. II.

50 per cent. Cut-off Locomotives.

The Shannon Power Scheme.

German Diesel Locomotive Design.

PUBLIC NOTICES

Ministry of Transport.
WATLING STREET, KENT.

The Minister is prepared to receive TENDERS for the STRENGTHENING and SURFACING with BITUMINOUS or ASPHALTIC CONCRETE MATERIAL of SECTIONS of the CARRIAGEWAY of Watling Street, Kent.

Forms of Tender, conditions of Tender, conditions of contract, bill of quantities, general specification and drawings may be obtained from the Chief Engineer, Roads Department, Ministry of Transport, 7, Whitehall-gardens, S.W. 1, upon payment of a deposit of £25. This amount will be returned to the tenderer, if his Tender is a bona fide one and has not been withdrawn prior to the definite acceptance of a Tender by the Minister.

Tenders, on the official form, accompanied by fully priced bills of quantities and a specification for the surfacing, to be furnished by persons or firms tendering, must be enclosed in a sealed envelope, marked "Watling Street Tender," and submitted to the undersigned on or before 10 a.m. on the 3rd day of June, 1925.

The Minister does not bind himself to accept the lowest or any Tender.

Dated this eighteenth day of May, 1925.

H. H. PIGGOTT,
Assistant Secretary.
Ministry of Transport. 9253

The Director - General,
India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—

1. BUFFER WASHERS and DIVISION PLATES.
2. INDIA-RUBBER SPRINGS for BUFFERS, &c.

Tenders due on the 5th June, 1925.
Tender forms obtainable from above. 9272

Applications are Invited
for the POST of JUNIOR TECHNICAL OFFICER to Assist in the Development of Designs at H.M.S. "Vernon," Portsmouth.

Salary, £175, rising by annual increments of £15 to £235, plus full Civil Service bonus. Present commencing salary, including bonus, £276 18s. The bonus varies according to the official cost of living figures.

The duties of the post are concerned primarily with the Design of Small Electrical and Acoustical Apparatus, and a sound knowledge both of Mechanical and Electrical Design is essential. A good grounding in Electrotechnics is required, but a University degree is of secondary importance.

Preference will be given to ex-Service men.

Applications, accompanied by a statement of qualifications, should be forwarded to the SECRETARY OF THE ADMIRALTY (C.E. Branch), London, S.W. 1, not later than the 8th June. 9254

Wanted at Once, Temporary Engineering Assistants
of good experience in Design of Docks and Heavy Masonry; also one experienced in Design of Reinforced Concrete Wharves; and another accustomed to Steelwork.

Also DRAUGHTSMEN; quick, accurate, with fair general knowledge of Civil Engineering and Building Construction.

Preference given to ex-Service men.

Apply, giving full particulars of experience, age, salary required, when disengaged, and enclosing copy of recent testimonials, to CIVIL ENGINEER-IN-CHIEF, Admiralty, S.W. 1. 9274

City of Cardiff Education Committee.
THE TECHNICAL COLLEGE.

Principal: CHARLES COLLS, B.Sc. (Lond.).

The SERVICES will be REQUIRED in September next of TWO FULL-TIME ASSISTANT LECTURERS in ENGINEERING, qualified in each case to teach up to Honours B.Sc. standard. The main subjects required will be those of Mechanical and Civil Engineering, but a good knowledge of Electrical Engineering will be a recommendation.

Salary scale: £300-£15-£450 per annum, with such variation in the scale as may be necessary by the application to Cardiff of the Burnham Award.

Applications on foolscap paper, stating age, full qualifications, teaching and other experience, and giving copies of not more than three recent testimonials, should reach the Principal (from whom further particulars may be obtained) on or before Saturday, 30th May.

The successful candidates will be required to pass a medical examination by the Authority's Medical Examiner for Teachers at Cardiff before commencing duties, and to contribute under the local pensions scheme, if not accepted under the School Teachers (Superannuation) Acts.

JOHN J. JACKSON,
Director of Education.
City Hall, Cardiff. 9165

Bengal-Nagpur Railway Company,
LIMITED.

The Directors are prepared to receive TENDERS for :—

(A) STEEL BOILER TUBES.
(B) 5 SUPERHEATED BOGIE MAIL ENGINES AND TENDERS, 4-6-0 Type.

Specifications and forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, E.C. 2, on or after 21st May, 1925.

A fee of 20s. will be charged for each specification, which is not returnable.

Tenders must be submitted not later than Noon on Wednesday, 3rd June, 1925.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the orders.

By Order of the Board,
R. C. VOLKERS,
9257 Secretary.

Bengal-Nagpur Railway Company,
LIMITED.

The Directors are prepared to receive TENDERS for :—

1500 STEEL TYRES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, E.C. 2, on or after 18th May, 1925.

A fee of 20s. will be charged for the specification, which is not returnable. Tenders must be submitted not later than Noon on Thursday, 28th May, 1925.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
9231 Secretary

PUBLIC NOTICES

County Borough of Southampton.
RECONSTRUCTION OF COBDEN BRIDGE IN REINFORCED CONCRETE.

TENDERS are INVITED for the RECONSTRUCTION of the above-mentioned BRIDGE, having five spans of about 75ft. each, including the PROVISION of a TEMPORARY BRIDGE, APPROACHES and all incidental works.

Drawings of the proposed works can be seen at the office of the Engineer for the work, Mr. H. W. Fitz-Simons, B.Sc., M. Inst. C.E., 30, Victoria-street, Westminster. Copies of the specification, bill of quantities and form of Tender are to be obtained from the Engineer's office on payment of Five Pounds, which sum will be returned upon receipt of a bona fide Tender and the return of all documents.

Sealed Tenders, endorsed "Cobden Bridge, Concrete," must be sent to the Town Clerk, Southampton, not later than Ten o'clock in the forenoon on Monday, the 15th day of June, 1925.

The Corporation do not undertake to accept either the lowest or any Tender.

R. R. LINTHORNE,
Town Clerk.
18th May, 1925. 9234

County of London.
REPAIRS TO PAVEMENT OF CARRIAGEWAYS OF BLACKWALL AND ROTHERHITHE TUNNELS.

The London County Council invites TENDERS for REPAIRS to the GRANITE SETT PAVEMENTS and GRANITE CHANNELLING of BLACKWALL and ROTHERHITHE TUNNELS.

The specification, form of Tender, drawings, &c., may be obtained on application to the Chief Engineer of the Council at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £3. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before the payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 8th June, 1925, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
9230 Clerk of the London County Council.

East Sussex County Council.
TRUNK ROAD RECONSTRUCTION SCHEME.
LONDON-BRIGHTON MAIN ROAD.
CONTRACT No. 2.

TENDERS are INVITED for the WORKS of RECONSTRUCTION, WIDENING and RESURFACING the CARRIAGEWAY of the LONDON-BRIGHTON MAIN ROAD from the boundary of the County Borough of Brighton to a point about half-mile north of the Muddlewood Crossways.

Plans and conditions of contract can be seen at the office of the Resident Engineer, London-road, Pangdean, and form of Tender, bills of quantities and specification can be obtained from the undersigned on payment of a deposit of Ten Pounds, which will be returnable only upon receipt of a bona fide Tender.

Sealed Tenders, endorsed "London-Brighton Road," are to be delivered at my office not later than the first post on Monday, the 15th June, 1925.

The County Council do not bind themselves to accept the lowest or any Tender.

F. J. WOOD, M.S.A., A.M.I.C.E.,
County Surveyor.
County Hall, Lewes,
20th May, 1925. 9265

PUBLIC NOTICES

Egyptian State Railways, Telegraphs and Telephones.
LIST OF APPROVED MANUFACTURERS OF CERTAIN SUPPLIES TO THE ABOVE ADMINISTRATION.

The said List is now under revision and all manufacturers who are interested, WHETHER PREVIOUSLY APPROVED OR NOT, are hereby invited to obtain further information either by application to the

GENERAL MANAGER,
Egyptian State Railways, Telegraphs and Telephones, Cairo,

or by subscribing to the "EGYPTIAN RAILWAY ADVERTISER."

This "Advertiser" is a weekly publication, in Arabic, English, and French. Subscription Fifty Egyptian Piastres or Ten Shillings and Sixpence yearly.

It is an organ of the Egyptian State Railways, Telegraphs and Telephones, containing information of interest to manufacturers, contractors and suppliers of materials and stores used by the Administration.

For particulars or registration of subscriptions apply to

PUBLICITY SECTION,
Egyptian State Railways, Telegraphs and Telephones,
9057 Cairo (Egypt).

Egyptian State Railways, Telegraphs and Telephones.
APPLICATIONS for the following APPOINTMENTS are REQUIRED and should be addressed to

THE GENERAL MANAGER,
c/o The Inspecting Engineer (Egyptian Govt.),
Queen Anne's Chambers,
Westminster, S.W.,

not later than June 10th, 1925.

1. ASSISTANT to CHIEF MECHANICAL ENGINEER, at £E1000 per annum, to be in charge of the Drawing-office.
2. DESIGNER, at £E600 per annum, to assist the candidate referred to above in (1).
3. TWO BOILER INSPECTORS, at a salary of £E480 each.

No other remuneration will be paid in addition to the salaries mentioned above.

Appointment will be made on contract for period of two years.

Copy of contract and list of qualifications required from applicant can be obtained from the Inspecting Engineer's Office. 9238

Southampton Corporation
WATERWORKS.
TO CONTRACTORS AND OTHERS.

The Corporation invite TENDERS for the LAYING and JOINTING of about 1600 YARDS of 12in. C.I. SPIGOT and SOCKET PIPES with Lead Joints from the South End of Chalk Hill to Moorhill Reservoir, West End, near Southampton.

Plans may be seen and specification, bill of quantities, and form of Tender obtained at the Waterworks Engineer's Office, 31, Shirley-road, Southampton, upon production of the Borough Treasurer's receipt for a deposit of One Guinea. Deposits will be repaid after the Council have dealt with the Tenders to contractors who have submitted bona fide Tenders and returned all the documents.

Sealed Tenders, endorsed "12in. Main, West End," on the prescribed form, with priced quantities and schedule, must be delivered at the Waterworks Engineer's Office on or before the 5th June, 1925.

The Council do not bind themselves to accept the lowest or any Tender.

R. R. LINTHORNE,
Town Clerk.
20th May, 1925 9258

PUBLIC NOTICES

The Great Indian Peninsula Railway Company,
48, Copthall-avenue, London, E.C. 2, invite TENDERS for—

1.	SHEFFIELD TOOLS	Fee 7s. 6d.
2.	PLATE GLASS, &c.	,, 2s. 6d.
3.	DRAWN or EXTRUDED BRASS STRIPS, ANGLES, &c.	,, 5s.
4.	CANVAS, &c.	,, 10s.
5.	SPARE PARTS of CARRIAGES and WAGONS (BUFFERS)	,, £1
6.	SPARE PARTS of CARRIAGES and WAGONS (AXLEGUARDS, &c.)	,, 7s. 6d.
7.	SPARE PARTS of LOCOMOTIVE ENGINES	,, 10s.
8.	STEEL DRAW-BARS, &c., for WAGONS	,, 5s.

Tenders are due by 11 a.m. on 9th June, 1925. Tender forms obtainable at above address. Fees not returnable. 9256

The Gondal Railway, India,
are prepared to receive TENDERS for the SUPPLY of :—

CARRIAGE UNDERFRAMES with STEEL BODIES and BOGIES.

Specifications, forms of Tender, and drawings may be obtained on application at the offices of ROBERT WHITE and PARTNERS, Consulting Engineers, 3, Victoria-street, S.W. 1, with whom the Tenders are to be lodged by Twelve Noon on June 22nd, the envelopes being marked "Tender for Steel Coaches."

A fee of Three Guineas will be made for each copy of the specification, which fee will be returned in the event of a bona fide Tender being lodged. 9259

The Madras and Southern Mahratta Railway Company,
Limited, 25, Buckingham Palace-road, S.W. 1, invite TENDERS for :—

16 BRAKE VAN UNDERFRAMES, 4-WHEELED.
10 BOGIE CARRIAGE UNDERFRAMES.
11 FOUR-WHEELED UNDERFRAMES.
ALL COMPLETE, EXCEPT WHEELS AND AXLES, METRE GAUGE.

Tenders are due on 16th June, 1925, by 2 p.m. Tender forms obtainable at above address, fee One Guinea, not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 9260

The Municipality of Singapore,
STRAITS SETTLEMENTS.
SEWERAGE DEPARTMENT—ASSISTANT ENGINEER.
ADVERTISEMENT.

The Municipal Commissioners of Singapore REQUIRE an ASSISTANT ENGINEER for the Sewerage Department, age 28-35, well educated, of sound constitution and preferably unmarried. Candidates must be qualified to design and construct sewers and sewerage details, including pumping mains, and must have special knowledge of the latest methods of the purification of sewage to the standard of the British Commission Report. The selected candidate should have had special experience on one or other of the various activated sludge systems at work in this country.

The appointment will be for three years, with possible extension. The selected candidate must pass a medical examination as to his fitness for service in Singapore. A passage will be provided with half salary during the voyage out.

The salary will be $160 dollars per annum, paid monthly, the value of the dollar being two shillings and fourpence sterling. At this rate the salary would amount to £952. An allowance for such transport as might be required on duty would be granted.

Applications, stating age and place of birth, and giving details of education, training and experience generally, stating when free, accompanied by copies (only) of testimonials, and also personal references, to be lodged with Messrs. PEIRCE and WILLIAMS, MM. Inst. C.E., 64, Victoria-street, London, S.W. 1, Agents to the Commissioners (from whom further information may be obtained), not later than Tuesday, 2nd June, 1925. 9241

PUBLIC NOTICES (continued) Page 2.

SITUATIONS OPEN

EXPERIENCED SALES MANAGER (35-40 Years) REQUIRED to Take Charge of London Office; must be thoroughly qualified Mechanical Engineer, with knowledge of Electrical Machinery; integrity, energy, method and enterprise essential qualifications; excellent prospects for right man. Only those with all these qualifications need apply. Applicants will please send full particulars as to age, education, technical and commercial experience, without testimonials.—Address, P646, The Engineer Office. P646 A

SITUATIONS OPEN, Page 2.

SITUATIONS WANTED, Page 2.

PATENTS, Page 2.

PARTNERSHIPS, Page 2.

AGENCIES, Page 2.

MISCELLANEOUS, Page 2.

FOR SALE, Pages 2, 3, 4 and 100.

AUCTIONS, Pages 3 and 100.

BUSINESSES and PREMISES (For Sale, etc.), Page 3.

MACHINERY, &c., WANTED, Page 2.

WORK WANTED, Page 6.

For Advertisement Rates see Page 575, Col. 1.

INDEX TO ADVERTISEMENTS, Page 99.

PUBLIC NOTICES

Bombay, Baroda and Central
INDIA RAILWAY COMPANY.
TWO TEMPORARY ASSISTANT ENGINEERS.

The Directors are prepared to receive APPLICATIONS (by letter only) for APPOINTMENT to the above POSTS on the Company's Railway in India.

Candidates should be between 24 and 28 years of age, and must have had a good general and technical education, and have obtained a Degree at a recognised Engineering College or have passed the Associated Membership Examination of the Institution of Civil Engineers. In addition, they must possess at least one year's practical experience with a railway company or on public works.

SALARY.—Rs. 450 and upwards per calendar month, according to age.

TERMS.—A three years' agreement in the first instance, first-class free passage to India and home again on satisfactory termination of services.

The selected candidates will be required to pass a strict medical examination by the Company's Consulting Physician before appointment.

Applications, giving full details of candidate's career, in chronological order (with dates), together with COPIES ONLY of testimonials, &c., must be addressed to the undersigned not later than the 5th June, 1925.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France, Westminster, S.W. 1,
15th May, 1925. 9255

SITUATIONS OPEN (continued)

MANAGING DIRECTOR WANTED, Capable of Taking Charge of Large and Important Manufacturing Works near London, with experience of Internal Combustion Engines.—Write, stating experience and qualifications, to CLIFFORD TURNER and HOPTON, Solicitors, 81, Gresham-street, E.C. 2. 9219 A

REPRESENTATIVE WANTED by Leading Makers of Oil and Gas Engines; must be able introduce new business; previous experience desirable.—Address, stating terms and full particulars, P630, The Engineer Office. P630 A

REQUIRED, the SERVICES of a Competent BOILER SHOP MANAGER. Applicant must be experienced in Lancashire, Cornish, Vertical, and Locomotive Type Boilers, and capable of rapid economical production, and should state where experience was gained, age, and salary expected.—Address, 9239, The Engineer Office. 9239 A

YOUNG Experienced ENGINEER, with First-class education and engineering degree, or equal qualifications, WANTED for London, to write technical matters for leading manufacturing engineers. Thorough knowledge of Internal Combustion Engines necessary.—Write in confidence, giving full particulars of experience, stating salary required, to Box 931, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, London, E.C. 4. 9250 A

CHIEF DRAUGHTSMAN, also DETAIL DRAUGHTSMAN REQUIRED, experienced in Baum Type Coal-washing Plant. Full particulars with salary required.—Apply, NORTONS (Tividale), Ltd., Hecla Works, Tipton. 9237 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, London, S.W. 1. 8768 A

DRAUGHTSMAN, Engineering, Preferably with some editorial experience, WANTED, part time.—Address, stating experience, terms, &c., P631, The Engineer Office. P631 A

DRAUGHTSMAN, First Class, for Design and Detail Work of all Commercial Vehicle Components.—State age, experience in full and salary required to DENNIS BROS., Ltd, Guildford. 9236 A

DRAUGHTSMAN (JUNIOR) REQUIRED in East Midlands, for Steam Engine and Boiler Work generally.—Write, stating age, experience, and salary required, Box 937, Sells Advertising Offices, Fleet-street, E.C. 4. 9216 A

DRAUGHTSMAN, Preferably with Experience in Dyeing and Finishing Machinery, REQUIRED.—Apply by letter, stating qualifications, age, salary, &c., to SAMUEL PEGG and SON, Alexander-street, Leicester. 9240 A

DRAUGHTSMAN REQUIRED, Capable of Designing with assistance. Must be quick and accurate. Preference given for knowledge of Laundry Machinery Permanent post if satisfactory. State age, experience, and salary required.—D.Y.B.T., BAKER PERKINS, Ltd., Laundry Department, Westwood Works, Peterborough. 9230 A

DRAUGHTSMAN WANTED for Large Engineering Works in Bombay, age not exceeding 30, single man preferred; General Engineering and Constructional knowledge essential.—Write, giving full particulars of career, to Box "Z.H. 636," c.o. Deacon's Advertisement Agency, 9, Fenchurch-avenue, London, E.C 3. 9273 A

DRAUGHTSMAN WANTED, Thoroughly Experienced in the design of Colliery Electric Winding Engines and Haulage Gears (mechanical portion).—Write, stating age, experience, and salary required, Box 938, Sells Advertising Offices, Fleet-street, E.C. 4. 9215 A

MACHINE TOOL DRAUGHTSMAN WANTED experienced in Special Tool design.—Address, stating experience, age, and salary required, 9105, The Engineer Office. 9105 A

REQUIRED for Important Argentine Railway, TWO first-class RAILWAY CARRIAGE and WAGON DRAUGHTSMEN, age under 35. Salary £350 to £400 plus £50 when working knowledge of Spanish has been acquired; 3 years' contract; first-class passage provided.—Reply, stating age and full details training and experience, with copies (only) of testimonials, to Box G. B., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 9252 A

REQUIRED for Important Argentine Railway, TWO LOCOMOTIVE DRAUGHTSMEN, age under 35, commencing salary about £400 per annum plus £50 when working knowledge of Spanish has been acquired; three years' contract; first-class passage provided.—Reply, giving age and full details training and experience, with copies (only) of testimonials, to Box R. F., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 9251 A

SENIOR DRAUGHTSMAN REQUIRED for Erection Plau Department, one with knowledge of Bakery Machinery, Conveyors, Driving Gears, &c., preferred; must be first-class man with initiative and capable of controlling men.—State age, experience, salary, to W. H., c.o. Baker Perkins Ltd., Peterborough. 9262 A

WANTED, Thoroughly Competent WORKING FOREMAN, trained in manufacture of Railway Signal Appliances and capable of fixing piecework prices for all classes of signal work. None others need apply.—State age, experience, and salary required to E. C. and J. KEAY, Ltd., Railway Signal Engineers, Darlaston. 9224 A

BLACKSMITH.—WORKING FOREMAN REQUIRED for Midland works. Must have all-round experience, be accustomed to piecework prices. Progressive position for suitable man.—Address, stating experience, age, and salary required, 9229, The Engineer Office. 9229 A

SITUATIONS OPEN (continued)

FOREMAN BOILERMAKER WANTED, Specially experienced in the manufacture of Lancashire and Cornish Boilers; only first-class men need apply.—Address, stating age, experience, and salary required, 9235, The Engineer Office. 9235 A

FOREMAN ENGINEER WANTED by Marine Engineers in China. Good Repair experience; Chief Engineer's Certificate; must have held responsible position with marine engineers in this country. Total abstainer.—Address, giving full particulars of experience, P638, The Engineer Office. P638 A

FOUNDRY FOREMAN.—WANTED for the Midlands, FOREMAN for Grey Iron Foundry for Engineering Jobbing Castings, Jobbing Pipes and Repetition Work.

Applicants will please state age, training, salary required, and when at liberty.

Present output 6 tons per day, but capacity up to 20 tons per day.

Address, 9223, The Engineer Office. 9223 A

WHITEMETALLER WANTED. Experienced Man for Lining Bronze Bearings on production scale.—Address, 9268, The Engineer Office. 9268 A

SITUATIONS WANTED

A CIVIL ENGINEER (37), Just Returned from abroad, DESIRES POST with Consulting Engineer or Contractor; good designer and surveyor; wide experience on important works; office or field.—Address, P636, The Engineer Office. P636 B

A.M.I.C.E. (34), Thorough Works and D.O. Training, locomotive, mechanical, steam, wide experience maintenance work and organisation and control of large staffs, keen economist, some commercial experience, Freemason, URGENTLY DESIRES PROGRESSIVE POST.—Address, P641, The Engineer Office. P641 B

CHARTERED CIVIL ENGINEER SEEKS APPOINTMENT; experience engineers' and contractors' side, and the carrying out of work by direct labour; reinforced concrete, pile driving, roads, bridges, railways, tunnels, caisson sinking, contract plans, parliamentary surveys.—Address, P623, The Engineer Office. P623 B

CHARTERED CIVIL ENGINEER (38). Twelve years' experience East, chiefly reinforced concrete design and construction, SEEKS suitable EMPLOYMENT, London or Hampshire, with Consulting Engineer or Specialist Firm. Small capital if necessary in young promising business.—Address, P632, The Engineer Office. P632 B

ENGINEER AND WORKS MANAGER AT LIBERTY. Good all-round engineering experience, organising and administrative ability; held responsible positions as works and chief engineer and works manager; energetic and disciplinarian; highest refs.; age 37.—M. EVERTON, Coleridge-road, Ashford, Middlesex. P608 B

ENGINEER, Young, with Good General Shop Exp., machine and press tool, motor, steam fittings, &c., Polytechnic train., now SEEKS OPENING in D.O.—Address, P645, The Engineer Office. P645 B

ENGINEER, Young, 7 Years' Works, Drawing-office and sea experience, SEEKS SITUATION in Drawing-office or as Assistant to an Engineer.—Address, "S.," 88, Inverness-place, Cardiff. P639 B

ENGINEER, Young Scotsman, 23, Desirous of going abroad, complete knowledge of Sugar Milling Machinery, WISHES SITUATION as ASSISTANT ENGINEER. Salary no object. Thoroughly qualified in the fitting and upkeep of mills. Excellent references.—Particulars from Box 75, Osborne-Peacock Co., Ltd., 82, Gordon-street, Glasgow. 9201 B

MANAGER, Works and General (39), At Liberty, with successful record, REQUIRES POSITION; constructional and general eng., including drop stamp, and mass prod. exp.; ex. refs.; home or abroad; moderate salary.—Address, P642, The Engineer Office. P642 B

WATERWORKS ASSISTANT (30) REQUIRES SIMILAR POST or as ASSISTANT MANAGER of Water Company; 10 years' experience all branches of water supply; excellent technical and personal qualifications; energetic and able to take charge of outdoor staff.—Address, P637, The Engineer Office. P637 B

JUNIOR DRAUGHTSMAN.—YOUTH (20), SEEKS POSITION; technical training, 3½ years prac.; locality immaterial.—HALL, 20, Aylesbury-road, Swansea. P635 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 70 years.

EDUCATIONAL

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter., B.Sc.), and ALL ENGINEERING EXAMINATIONS, personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours) Eng., London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.R.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of Successes. Courses may commence at any time.—Apply to Mr. TREVOR W. PHILLIPS, B.Sc. (Hons.), A.M.I.C.E., &c., 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN-STREET, LIVERPOOL. Ex. B

SURVEYING AND LEVELLING.—EXCELLENT OPPORTUNITY to ACQUIRE thorough practical INSTRUCTION on WORK.—Address, E. MOUL, Hollybank, Woking. P622 B

TUITION BY POST.—Inst. C.E. and I. Mech. E. Enrol now for next Exams; 100 per cent. passes last examination. Reinforced Concrete, new comprehensive course under expert engineer, £3 3s. Write for particulars.—PENNINGTONS, University Tutors, 254, Oxford-road, Manchester. Estab. 1876. Ex.

TUITION BY CORRESPONDENCE.
Expert tuition in Mathematics, Mechanics, Machine Construction and Drawing, and for B.Sc. (Engineering) and other examinations.
Mr. J CHARLESTON, B.A.
(Hons. Oxon & Lond.).
14, Elsham Road, Kensington, London, W. 14.

AGENCIES

A FIRM IN PARIS, which is Engaged in the Manufacture of MECHANICAL DEVICES AND ACCESSORIES FOR MOTOR CARS, Aeroplanes and the Chemical Industries, and which is well placed on the FRENCH MARKET, is willing to take a GENERAL AGENCY FOR FRANCE FOR A BRITISH OR AMERICAN FIRM which makes and sells machines or devices of a nature similar to its own products. Financial participation is essential, £2000 or more being required, according to conditions. French director who speaks English, and is conversant with both British and metrical measurements and calculations.—Address, P643, The Engineer Office. P643 D

AN Old-established FIRM of ENGINEERS in Westminster, having an extensive sales organisation and valuable connection amongst railways and tramway authorities at home and abroad, are desirous of extending their field of operation and would be PREPARED to ACT as LONDON REPRESENTATIVES for one or two British Firms manufacturing suitable specialities.—Address, 9233, The Engineer Office. 9233 D

ENERGETIC ENGINEER, About to Visit Africa, DESIRES to REPRESENT Agricultural and General Engineers; makers of Pumps and Oil Engines considered.—Address, P633, The Engineer Office. P633 D

MISCELLANEOUS

TRANSLATIONS (French and German). Accuracy and prompt service.—R. SWIFT, 85, Bishop-street, Moss Side, Manchester. Many years' experience in engineering trade. P607 I

PATENTS

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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

Oil Pollution in Coastal Waters.

AT the recent meeting of the Committee of the International Shipping Conference appointed to examine the subject of oil pollution in coastal waters, representatives from Australia, Belgium, France, Great Britain, Germany, Holland, Italy, Norway and Sweden were present, as well as representatives from the Royal and International Societies for the Protection of Birds. After considering the evidence and information tendered at that meeting, it was the considered opinion of those present that the nuisance of oil pollution has to a large extent been overcome by the measures which shipowners have adopted. It was pointed out, however, that the Committee has no power to deal with the discharge of oil from naval vessels, which is being dealt with by the various naval authorities of the different nations. A more uncertain source of pollution is the oil released from the breaking up of wrecks around the coast which presents a difficult problem. While we learn with pleasure of the partial mitigation of the nuisance and have the assurance that shipowners will continue to do all in their power to prevent oil being discharged near the coast, it is significant that only a week or two ago a petition signed by more than 18,000 residents in the Isle of Wight was presented to the Prime Minister protesting against the wholesale destruction of birds and fishes around the island by oil discharged from ships. It is to be hoped that the measures taken by the Committee and the Admiralty will in future effectively prevent the recurrence of such pollution.

Cheap Electrical Power.

SPEAKING to the Oxford University Conservative Association last Friday, the Prime Minister remarked that in the provision and use of electrical power this country was lagging behind others of far less industrial importance than our own. Not only did we use too little but for what we used we paid too much. He believed that unless the situation were remedied quickly, the discrepancy between what we paid for electrical power and what we ought to pay if the country were adequately equipped would increase year by year until we would be unable to compete with anything or anybody. The report of the expert committee, presided over by Lord Weir, which the Government appointed to consider the problem as soon as it came into power, was, he announced, now completed, and would be examined by the Cabinet with the greatest care. If the Committee's policy were endorsed, the measures required to give it effect would, he said, be the first and most important duty undertaken by the House of Commons on the re-assembling in the autumn.

The Barking Power Station.

ON Tuesday last the King opened the new Barking power station of the County of London Electric Supply Company. As long ago as 1913 the company obtained parliamentary powers for the establishment of the Barking scheme, but the war and later legislative and other troubles prevented its progress. The cost of the first section of the power house and mains has been about £2,500,000. It was on June 13th, 1922, that the building of the station was formally authorised by the Electricity Commission, and in March of this year some idea of the extent of the undertaking was given to the shareholders in the County of London Company by the managing director, Sir Harry Renwick, who claimed that the capital cost per kilowatt installed was below that of any other station of comparable size erected since the war. Although there is much diversity of opinion concerning the advantages of super-power stations, the opening of the Barking station is considered by those who have been responsible for it to mark a new era in the development of electricity supply in this country, and more particularly for London. The station site covers about 100 acres, with a river frontage of 2100ft., but the company also controls adjoining land to the extent of 300 acres, with river and rail access. This site has been levelled preparatory to being let for the erection of factories, particularly for those needing large supplies of electrical energy.

The Blue Star Line Orders.

WHEN dealing with the shipbuilding trades investigation in a Journal note of the 8th inst., reference was made to the inquiry for eight new refrigerator steamers which had been sent out by the Blue Star Line, Ltd., and the unfavourable prices which were quoted by British shipbuilders, compared with those of the Dutch and German yards. Efforts have been made to secure this valuable order for home shipbuilding yards, and it is satisfactory to learn that two steamers have been placed with Lithgows, Ltd., of Port Glasgow, and two with Palmers' Shipbuilding and Iron Company, Hebburn and Jarrow-on-Tyne. The remaining four ships are now being negotiated for. In a statement issued by Sir Edmund Vestey, the price of the eight steamers is given as amounting to over £2,700,000, and the owners are stated to have sacrificed £300,000 in placing the orders with British shipbuilding firms. The steamships in question are to have a deadweight tonnage of 12,000, and will be propelled by twin-screw single-reduction geared turbines of about 5800 shaft horse-power, designed for a service speed of 14 knots. It is of interest to note that although prices for motor-propelled vessels were originally quoted, and this type of machinery was very carefully considered, it was found that owing to the high degree of flexibility demanded by the refrigerating plant, steam working was preferable and more economical, and geared turbine propelling machinery, with steam-driven auxiliaries, was therefore decided upon. In ordering these ships the Blue Star Line, Ltd., has, it is stated, taken advantage of the Trade Facilities Act, which means that at least a large proportion of the raw materials required will be purchased in this country.

Sir Frank Dicksee and British Engineers.

SPEAKING at a dinner last Friday of the Architecture Club, Sir Frank Dicksee, president of the Royal Academy, referring to Waterloo Bridge, is reported to have remarked that he had not the least idea whether English engineers felt competent to preserve the structure, and that if English engineers could not undertake the task American, French or Italian engineers could be found "who would put forward an idea that would make it possible." Our engineers, he continued, might be put on their mettle if they were placed in competition with those of other countries. Sir Frank, like some other artists and architects, desires to have Rennie's structure preserved primarily because of its artistic merits. The London County Council favours its being rebuilt in a widened form or preferably demolished and an entirely new structure erected in its place, because it desires to carry its tramways across the bridge. Whichever course is decided upon, Sir Frank may rest assured that British engineers will be able to carry it out. The real trouble seems to lie not in the inability of British engineers to preserve Rennie's bridge, but in the inability of British architects to design a modern structure fit to take its place. There is not the least ground for Sir Frank Dicksee's suggestion that incompetency on the part of British engineers is a factor in the problem.

Secret Wireless

THE Postmaster-General is reported to have offered a new company, known as Secret Wireless, Ltd., licences in respect of two wireless transmitting stations for broadcasting purposes. Reports on the matter are somewhat conflicting, but it appears that the company in question has introduced a transmitting system which differs from that now in use and which will call for an additional component on all receiving sets. Without the use of this component reception from the new stations will be impossible. Technical details of the scheme are not available, but we might call our readers' attention to the fact that an abstract of a patent granted to the Marconi Company for a system of transmission involving the use of special receivers was given in THE ENGINEER of October 3rd, 1924. Briefly it is proposed to add to the outgoing music or speech powerful interfering tones which would distort the transmission and spoil the quality of reception on an ordinary receiver. In special sets designed for the reception of the transmissions, however, the interfering tone would be eliminated by means of filters. The new company's system may, of course, work on quite different lines, but in any case the existence of this patent is worth recording. The new company, it seems, has an experimental station at Birchington, Kent, which will be ready for experimental transmission in about twelve days' time.

The Largest Japanese Submarine.

A TOKYO cable despatch announces the completion of a new submarine, I. 53, the largest that has been built so far for the Japanese Navy. Her displacement is given as 1700 tons, and she has a cruising endurance sufficient for a voyage across the Pacific and back. In the British official return of fleets, published recently, the I. 53 was bracketed with seven other Japanese submarines all above 1000 tons as being under construction. In addition to these, four submarines of less than 1000 tons were shown as building, and sixteen others as projected and authorised. Until the completion of the I. 53 the largest Japanese boat in service was the I. 51, laid down in 1921 and completed last year. She displaces 1500 tons and has engines of 6000 horse-power, which should be equivalent to a speed of 21 knots. The armament of these large Japanese submarines has yet to be disclosed, but it is known that certain boats of the latest construction are to mount guns of 5.5in. calibre. According to the British return, the Japanese submarine flotilla will eventually have a strength of seventy-nine boats. The same authority states that I. 53 was begun in 1924, so that she has apparently been built in little more than twelve months. This is a very striking performance, having regard to her large dimensions. In size, however, she is exceeded by the British X. 1, which is 1080 tons heavier, and also by our boats of the "K" class, though she is slightly larger than our "M" class submarine monitors, which mount a 12in. gun. The American submarine V. 1, completed last year, is larger by 464 tons than the Japanese vessel.

A Coal Mine Scheme Rejected.

As was feared, the workmen at the Birchenwood Colliery, Kidsgrove, Stoke-on-Trent, have decided to reject, on the advice of their leaders, the scheme proposed by the owners for the co-operative working of the colliery. The scheme, as was mentioned in a Journal note in our issue of May 8th, involved the creation of a trust fund to which the royalty owners, the staff and the workmen were to contribute 15 per cent. of the payments accruing to them. The directors have expressed great disappointment with the men's decision. The pit is being worked on day-to-day contracts, but how long it will remain open is not known. The Kidsgrove Urban District Council has interested itself in the matter. On Friday it sent a deputation to the Mines Department of the Board of Trade and suggested that the Government should guarantee a loan to be raised locally at Kidsgrove for the purpose of paying off the debenture holders and so ensure the pit being kept open. The Secretary of the Mines Department intimated that as the money required to be guaranteed was not to be applied to works of development it was unlikely that the Treasury would accede to the application.

James Watt's Attic Workshop.

FROM the annual report on the Science Museum, which the Board of Education has published this week, we learn that the contents of James Watt's attic workshop, so long and carefully preserved at Heathfield Hall, near Birmingham, will shortly be exhibited at South Kensington, thanks to the generosity of Major J. M. Gibson Watt. A special room is being prepared at the Museum for their reception. This room, through the kindness of the present owners of the Heathfield Hall estate—now or about to be used for building purposes—will be fitted with the actual door, windows, floor boards and other fixtures of the attic used by Watt. Watt's machines, tools, &c., will be set out precisely as he left them at the time of his death in 1819, and as they have ever since been maintained. The room will be situated only a few yards from the Boulton and Watt engines preserved at the Museum, so that visitors will have an excellent opportunity of studying and appreciating the conditions under which the early steam engines were developed.

The Position of the Coal Industry.

THE first report of the Joint Committee appointed by the Mining Association and the Miners' Federation, to investigate the economic position of the coal industry, was issued last Friday. From the engineering point of view, it is of interest because of the comparison it makes of the mechanical equipment of British coal mines in 1924 with the equipment of 1913. During the period indicated the number of machine coal cutters in use increased from 2897 to 6830, and the number of mechanical conveyors from 377 to 1373. At the same time the aggregate power of the electric motors in use increased from 628,098 to 1,481,932 horse-power. In spite of this increased amount of equipment, it is not pleasing to note that the output of coal per shift suffered a fall from 20.32 cwt. to 17.86 cwt. Per ton of coal commercially disposable the wages and other costs of production just doubled during the period, rising from 9s. 5½d. in 1913 to 18s. 11.74d. in 1924. The balance of the proceeds after deducting the cost of product fell from 1s. 6½d. to 0/3.09d. It is stated that while sea freights in the coal-carrying trade are to-day only 5 to 10 per cent. above the pre-war figures, railway freight rates have increased from 50 to 70 per cent., and charges for shipment at the ports by as much in some cases as 213 per cent.

Wages in the Engineering Industry.

ON Wednesday a conference of representatives of the executives of the various trades unions connected with the engineering industry declined unanimously and emphatically to negotiate with the Engineering and Allied Employers' Federation on the basis laid down by that body on April 22nd. The men demanded some considerable time ago an all-round wages increase of 20s. per week, and at an early stage in the ensuing discussions made it clear that they objected to other questions, such as working hours and workshop conditions, being incorporated in the matter. The employers on April 22nd submitted a scheme under which wages would be advanced by virtue of an extension of the working week from forty-seven to fifty hours and by an increase of 2s. in the present war bonus of 10s. per week. Incidentally the extra allowances for overtime and night-shift working were to be reduced. That offer, made with the object of assisting the industry to meet foreign competition and so permit of increased employment and higher wages, has now been definitely rejected. The next stage in the controversy will be awaited with anxiety.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XXI.*

PERIOD 1860 TO 1865 (*continued*).

Passenger Tank Engines.—Between 1860 and 1865 several interesting new types of tank engines were constructed, the majority of which embodied flexibility of wheel base. There has always been more scope for variations of tank engine design, more especially in the wheel arrangements, than in the case of tender engines.

Of the six-wheeled tank engines with rigid wheel base, several railways, such as the Manchester, Sheffield and Lincolnshire, and London, Chatham and Dover, preferred the 2–4–0 type with double frames. In 1861 Beyer, Peacock and Co. introduced the inside-framed engine—Fig. 158. These engines were built by the firm for more than twenty years for branch line traffic on home and foreign railways. The earlier engines had 5ft. coupled wheels, 15in. by 20in. cylinders, and 120 lb. pressure. Later engines, in which the dome was placed over the middle of the barrel, had 5ft. 6in. wheels, 16in. by 24in. cylinders, and 140 lb. pressure.

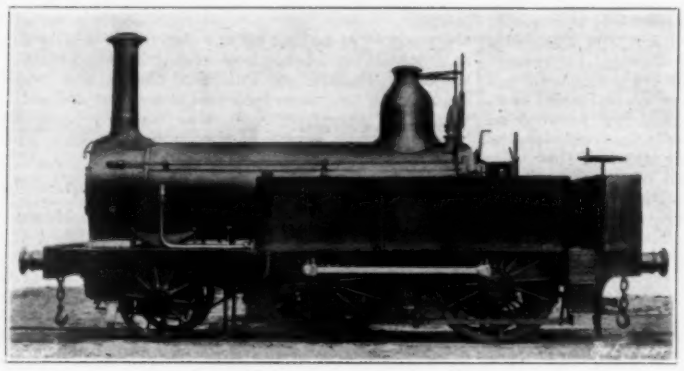


FIG. 158—BEYER PEACOCK'S TANK ENGINE, 1861

A minority of engineers adopted the 0–4–2 tank engine. Amongst them were McConnell, on the L. and N.W.R. (Southern Division) and Cudworth, on the S.E.R. The former used inside and the latter outside framing, and in both cases the tanks were at the back. McConnell's engine—Fig. 159—had 5ft. 6in. coupled wheels, 4ft. trailing wheels, and 15in. by 22in. cylinders. The first five of 1860 had domes, raised fire-box casings, and combustion chambers, but in the last ten of 1862 the domes and combustion chambers were discarded, and the casings were flush, as shown in the illustration. All were built at Wolverton and were the first L. and N.W.R. tank engines to work the local trains in the London district.

FIG. 159—McCONNELL'S TANK ENGINE, 1862

Joseph Beattie's celebrated outside cylinder 2–4–0 well tank engines—Fig. 160—of which there were about eighty, cannot be passed over. With the exception of three, all were built by Beyer, Peacock and Co. from 1863 to 1874, and until about 1890 most of them worked the extensive local traffic in the London area. Although of small size, they were extremely smart and fast-running engines, even with fairly heavy loads. All had Beattie's patented fire-boxes and feed-water heating apparatus. The cylinders were 15½in. by 20in. (those built after 1871 16in. and 16½in. by 20in.); wheels, 3ft. 7½in. and 5ft. 6in.; wheel base, 5ft. 6in. + 7ft. The boiler, 3ft. 8in. diameter inside the smallest ring, contained 224 1⅝in. tubes; heating surface: tubes, 858 square feet, fire-box, 80 square feet, total, 938 square feet; grate, 14.8 square feet; pressure, 130 lb.; weight in working order: leading, 10 tons 10 cwt.; driving, 11 tons 12 cwt.; trailing, 12 tons 7 cwt.; total 34 tons 9 cwt. A water tank was placed between the frames over the leading axle; another, also between the frames, was under the foot-plate. The slide valves of the later engines were balanced. All had Allan's straight link motion.

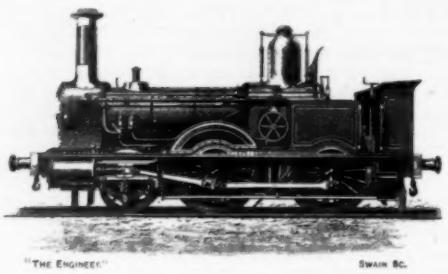


FIG. 160—BEATTIE'S TANK ENGINE, 1863

* No. XX. appeared May 15th.

Sectional drawings were given in THE ENGINEER of February 5th, 1892.

On January 10th, 1863, the Metropolitan Railway was opened between Bishop's-road and Farringdon-street. It was then a broad—7ft.—gauge line, and for some months was worked entirely by the G.W.R. broad gauge tank engines—Fig. 161. These, designed by D. Gooch, were probably amongst the most ungainly and clumsy locomotives of their day. Unlike those of all other G.W.R. broad gauge engines, the cylinders were outside, and owing to the width of the gauge, were spaced at about 8ft. 2½in. centres. In addition, they were somewhat steeply inclined to clear the leading wheels. The outside position of the cylinders was adopted to make room for the tanks and condensing apparatus, of which the flap valves were placed below the smoke-box. The tanks were placed partly under the boiler and partly under the foot-plate. The latter tank was too far removed from the cylinders, and the tank below the boiler was left to do practically all of the condensing. Flap valves, worked by rods from the foot-plate, directed the exhaust steam either up the chimney or into the tank under the boiler. The condensing pipe from the right-hand cylinder crossed to the left-hand side of the tank, and that from the left-hand cylinder to the right-hand side, to obtain sufficient length and flexibility. They were prolonged within the tank, being perforated with holes to distribute the exhaust steam. The arrangment was defective, since the placing of condensing pipes below the water level and the production of a vacuum in them when steam was shut off resulted in the risk of drawing water into the cylinders. To prevent such a mishap additional automatic flap valves were placed in the exhaust pipes, but there was much difficulty in keeping them water-tight. Stated briefly, when the pipes and

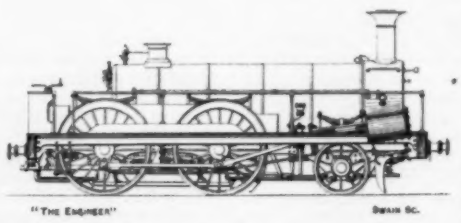


FIG. 161—D. GOOCH'S TANK ENGINE, 1862

connections were not engaged in sucking air from the outside, they were busily employed in allowing water to leak out from the inside. The tanks had insufficient capacity, got overheated, and the chimney exhaust had to be resorted to in the tunnels.

These engines had 16in. by 24in. cylinders, 6ft. coupled wheels, and a rigid wheel base 8ft. + 7ft. 6in. There were 22 of them, of which six were built by the Vulcan Foundry, 1862; six by Kitson, 1863, and the remainder at Swindon in 1863–4. They were the first condensing tank engines to be put into service. There were also two similar standard gauge engines, built at Swindon in 1864, with 5ft. 6in. coupled wheels and 15in. by 24in. cylinders. Some of them were converted to 2–4–0 tender engines and the condensing gear removed, after which they lumbered along for a few years between London, Windsor, and Reading.

The addition of arrangements for making the wheel base flexible was the cause of a large increase in the number of eight-wheeled tank engines.

The 2–4–2 radial tank engine first appeared in November, 1863, and was provided with W. Bridges Adams's radial axle-boxes at both ends. This engine, the White Raven (Fig. 162) was built by Cross and Co., St. Helens, for the St. Helens Railway, but before being placed in regular service was tried on the North London Railway. In addition to the radial axle-boxes, the engine was fitted with the Adams patented spring tires. Between the rim of the wheel and the tire, which was of Krupp steel, a steel hoop spring was placed round the wheel, with the object of making the tire fit the wheel elastically, being neither too loose nor too tight. Mr. Adams considered this the safest form of tire, as it had no tendency to burst; it had sufficient yield to minimise the effect of blows, and was pliant enough to cause better adhesion between tire and rail.[1]

The "White Raven" had 15in. by 20in. cylinders, coupled wheels, 5ft. 1in. diameter; radial wheels, 3ft. 3in. leading and 3ft. 1in. trailing; wheel base, 7ft. + 8ft. + 7ft. = 22ft.; heating surface, 687 square feet.; pressure, 140 lb.; capacity of tanks, 950 gallons; coal capacity, 25 cwt.; weight loaded: leading, 7 tons 15 cwt.; driving, 11 tons 15 cwt.; coupled, 11 tons 5 cwt.; trailing, 10 tons; total, 40 tons 15 cwt.

Since the radial axles were the principal feature, some particulars of them are given. The first idea of a radial axle appears to have originated with the French engineer, Edmond Roy, in 1857, but the arrangement was defective. At the same time a Mr. Strong, of the Caledonian Railway, proposed what was in most respects a similar idea to that subsequently adopted by Adams, but had straight instead of curved guides. It was mechanically defective in that the axle-boxes would have had to be slack in the guides. Nevertheless, some shunting engines with this arrangement were built in Germany, even after Adams's much improved axle-boxes had appeared.

In Adams's patent of 1863 the axle-box itself was made with curved sides which worked inside corresponding curved guides on the horncheeks. The outside journals were each made with a central collar which worked inside a corresponding recess in the brass, and the lateral movement of the axle was transmitted to the axle-box through the collar and brass. In the White Raven each radial axle-box had a lateral movement of 4½in. each side, and the radii of curvature were struck from the centre of the nearest coupled axle, in this case 7ft. distant. One thing was lacking, viz.: the employment of some form of controlling arrangement, and neither spring control nor inclined planes were used with these early axle-boxes. The result was that the engine was too flexible, with a tendency to excessive lateral oscillation. The "White Raven" came into possession of the L. and N.W. Railway when the latter absorbed the St. Helens Railway in 1867, and a few years afterwards the radial axle-boxes were removed, and the engine was converted into a 2–4–0 tender engine with rigid leading axle. Nevertheless, Adams's system was the origin from which all modern forms of radial axles, including the

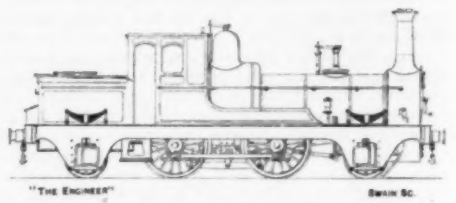


FIG. 162—THE "WHITE RAVEN," 1863

Webb type, have been derived, and on the Continent of Europe such axles are to this day termed "Adams axles."

Unlike the radial axle-boxes, the patent spring tires did not meet with extended application, and appear to have been soon discarded.

In 1864 Robert Sinclair designed the 2–4–2 tank engine shown in Fig. 163, of which twenty were built by Neilson and Co. for the Great Eastern Railway to work local trains in the London area and country branches. They differed from the "White Raven" in that the leading axle formed part of a Bissell truck, but the trailing axle was rigid. In this and other respects their design followed that of the 2–4–2 tender engine, built by Messrs. Stephenson for the Luxembourg Railway in 1860 to Sinclair's general instructions.

The pin of the Bissell was attached to the boiler

[1] See "Proc.," Inst. C.E., Vol. 23, 1863–4; also Colburn's "Locomotive Engineering," pages 276–278, where a full description of the engine is given.

through the intermediary of cross plates and angle irons. To transmit the weight of the truck a hemispherical pivot, 6¼in. diameter, was fixed to the barrel about 1in. in front of the leading wheels and fitted into a corresponding recess in a transverse cast iron girder. At each end of and forming part of this girder were double inclined planes, which rested upon corresponding planes of steel fixed on the transverse plate of the truck. When the engines were new the planes were inclined at 1 in 6, and had a tendency, when returning to the central position, to come down with a slam. The incline was afterwards reduced to 1 in 24, and the amount of lateral movement was increased from 1in. to 1¼in. on each side. The length of radial arm was 4ft. 2in.

The cylinders, 15in. by 22in., were outside, as in all Sinclair's engines. Coupled wheels, 5ft. 7in., carrying wheels, 3ft. 7¼in. diameter; wheel base, 5ft. 4in. + 6ft. + 6ft. = 17ft. 4in.; overhang of frames at each end, 5ft. 9in.; boiler barrel, 13ft. 6in. long by 3ft. 11in. diameter outside; heating surface, of 143 1⅞in. tubes, 966 square feet; total, 1034¾ square feet; pressure, 120 lb.; weight in working order, leading, 8 tons 7 cwt., driving, 9 tons 14 cwt., coupled, 9 tons 4 cwt., trailing, 9 tons 1¼ cwt.; total, 36 tons 6¼ cwt.

Radial axles were not, however, confined to eight-wheeled tank engines, and in 1864–6 A. Sturrock designed some 0–4–2 back tank engines in which the trailing axles were provided with Adams's radial axles. All the bearings were outside, and the main frames were of the sandwich pattern which Sturrock used for all his engines. There were twenty of these engines, fifteen by the Avonside Engine Company and five by Neilson on the Great Northern Railway, and fourteen more by Neilson on the London, Chatham and Dover Railway. The G.N.R. engines, one of which was illustrated in THE ENGINEER, December 1st, 1922, page 580, Fig. X., had domes on the middle of the boiler, but in the Chatham engines—Fig. 164—they were placed on the front ring.

The cylinders were 16½in. by 22in.; coupled wheels, 5ft. 6in.; and the trailing wheels, 4ft. diameter. The Chatham engines of 1866 had 183 brass tubes 2in. diameter in a boiler barrel 4ft. 1¼in. diameter outside. Their total weight in working order was:—Leading, 13 tons; driving, 14 tons 2 cwt.; trailing, 14 tons 5 cwt.; total, 41 tons 7 cwt.

The wheel bases differed. That of the first ten G.N.R. and of the L.C.D.R. engines was 7ft. 6in. + 11ft. 9in., but in the second ten G.N.R. engines was 12ft. 9in. between driving and trailing wheels. The radii of curvature of the centre lines of the axle-boxes were 7ft. 9in. and 8ft. 6in. for the two engines respectively. The radial axle-box bearings were 16in. by 6in. diameter, with central collars 7½in. diameter by 2in. wide, and the main bearings also had central collars. The tops of the radial axle-boxes were flat, and the spring pillars had sliding brass shoes. The lateral movement was 2½in. each side, but there was no controlling force.

These were excellent engines and performed a vast amount of hard work for many years. Their fault was considerable oscillation at the trailing end at high speeds, owing to the great length of wheel base between the driving and radial axles, and absence of controlling force. This oscillation was transferred to the front van or coach of the train, in which the movement was sometimes very uncomfortable.

The 4–4–0 outside cylinder engines—Fig. 165—of the Metropolitan Railway, by Beyer, Peacock and Co., 1864, remain to be described. They were not the first of the type, since the same firm had built eight very similar, but smaller, engines for the Tudela and Bilbao Railway, Spain, in 1862. The four-wheeled leading truck was on the Bissell system, and in the Metropolitan engines was pivoted 6ft. 8in. behind its centre line. The wheel base of the truck was 4ft.; that of the coupled wheels, 8ft. 10in.; total base, 20ft. 9in.; the cylinders were 17in. by 24in., and to clear the truck, were placed at a considerable inclination; diameter of coupled wheels, 5ft. 9in., and of truck wheels 3ft.; the tires were of Krupp steel; the boiler, 4ft. diameter inside the smallest ring, contained 166 2in. tubes, which provided 912.6 square feet of heating surface, to which the fire-box added 101.2 square feet; pressure, 130 lb.; tank capacity, 1000 gallons; weight in working order: truck 11 tons 3 cwt., driving 15 tons 9½ cwt., trailing 15 tons 10 cwt., total 42 tons 3 cwt.; weight empty, 35 tons 8¾ cwt.

The principal feature was the condensing apparatus for use in the tunnels. The exhaust steam was "shunted" from the blast pipe into a large pipe, entering the top of the tank, and was discharged upon the surface of the water. The result was that the upper portion only of the water in the tank was heated, and there was no circulation. A smaller pipe with open upper end was then added. This end entered the mouthpiece of the larger pipe for a short distance, and the lower end, also open, dipped into the tank. The greater part of the steam found an exit through the annular space between the pipes, and played upon the surface of the water, but sufficient steam passed into the small pipe and caused circulation of the water. The tank capacity of the later engines of 1879 to 1884 was enlarged to about 1140 gallons, and the weight in working order increased to 46¾ tons, of which the driving wheels carried 18 tons 18 cwt. and the trailing wheels 17 tons 18 cwt.

The four-wheeled Bissell bogie truck appears to have left something to be desired. The engines built between 1864 and 1871 were provided with it, but in those from 1879 onwards an Adams sliding bogie, with central pivot, was substituted, and most, if not all, of the older engines were altered to this system. The wheel base of the bogie remained 4ft., as in the earlier engines. That the original design, in spite of the large coupled wheels, proved extremely satisfactory, is borne out by the fact that Beyer, Peacock built no less than 148 of these engines, of which 120 were in use on the Metropolitan and the District railways. The L. and N.W.R., Midland and L. and S.W.R. had twenty-eight between them. Five others were built in 1871 for the Rhenish Railway (Germany). The last of the type were delivered to the Metropolitan Railway in 1886. A complete list of detailed dimensions of the later engines was given in THE ENGINEER, May 17th, 1889, page 415.

The original No. 1 of 1864 ran 632,145 miles before being re-boilered in 1887. The original boilers were of Yorkshire iron. No. 1 was also the first to be broken up, as the result of an accident in 1897, and then had 1,050,000 miles to her credit.

The handsome 4–4–0 side tank engines—Fig. 166—were built at the Bow Works of the North London Railway between 1863 and 1869, to the designs of William Adams, following the general lines of Stephenson's tank engines of 1855 for the same railway, but the bogie was of a much improved type, with longer wheel base. The engines of 1865 and later, of which the illustration shows one, were considerably larger and the bogies were the first to be provided with lateral traverse for the pivot. The bogie frames were outside, 6ft. 6in. apart, and connected transversely at the middle by two channel irons faced with steel on their upper sides. The pivot, 6in. diameter, passed through a bush arranged to slide laterally on the steel faces, with a traverse of 4½in. each side, but in the first engines there was no controlling force. Soon afterwards india-rubber side check springs were added. The bogie wheel base was 6ft. A single inverted spring took the load on each side. All axles and tires were of steel. The coupling rods were of Bessemer steel and in the engines built from the beginning of 1866 were made with Ramsbottom's bushed ends, for which Adams used cast iron bushes lined with white metal. As compensating levers were placed between the springs of the coupled wheels, the spring-borne weight was carried on three points, a system to which Adams consistently adhered for many years.

The inside cylinders, 17in. by 24in., were inclined at 1 in 18, and placed at 2ft. 4in. centres; coupled wheels, 5ft. 9in. diameter (increased subsequently to 5ft. 11in. with thicker tires); bogie wheels, 3ft. diameter; wheel base, 6ft. + 8ft. 2in. + 8ft. = 22ft. 2in.; the boiler, 11ft. 8in. long by 4ft. 1in. diameter, contained 120 brass tubes, 2½in. diameter; heating surface of tubes, 846 square feet, of fire-box 112 square feet, total 958 square feet; grate area, 16½ square feet; total weight in working order, about 42 tons, of which 30 tons were available for adhesion. The high boiler pressure of 160 lb. was carried.

Four-wheels Coupled Goods Engines.—The last of Bury's type of 0–4–0 engines with bar frames was built for the Furness Railway in 1861 by W. Fairbairn and Sons, who still adhered to this design after the disappearance of the firm of Bury, Curtis and Kennedy. A more modern type of 0–4–0 engine for use on mineral branch lines was subsequently built by Sharp, Stewart and Co. for the same railway, and by P. Stirling at Kilmarnock Works for the Glasgow and South-Western Railway. These engines had plate frames, and, unlike the Bury and Fairbairn engines, had cylinders inclined downwards towards

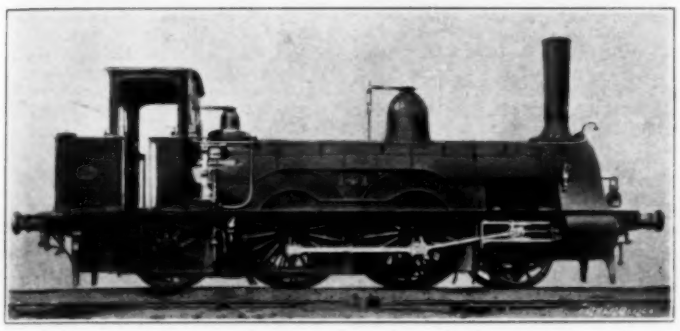


FIG. 163—SINCLAIR'S TANK ENGINE, 1864

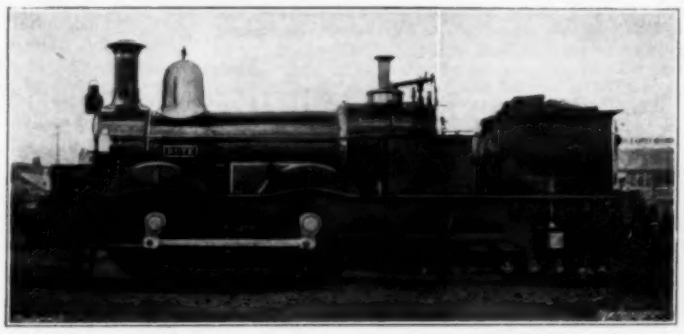


FIG. 164—L.C. AND D. RAILWAY TANK ENGINE, 1866

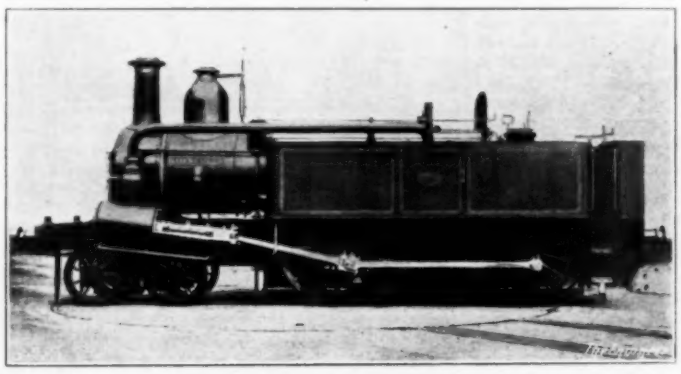


FIG. 165—METROPOLITAN TANK ENGINE, 1864

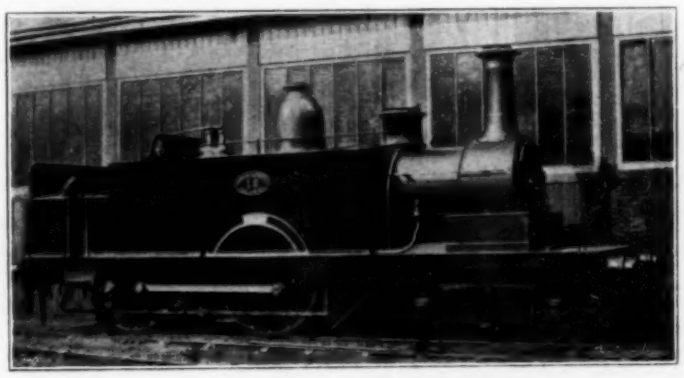


FIG. 166—W. ADAMS' TANK ENGINE, 1865

the back with slide bars above the leading axle.

Some 0–4–2 engines of excellent design were built, 1859 to 1864, mostly by Beyer, Peacock and Co., for the Edinburgh and Glasgow Railway. In them the small trailing wheels had outside bearings to keep the journals away from the heat of the fire box. These engines, which had 5ft. wheels and 16in. by 22in. cylinders, were in service for about forty-five years.

P. Stirling's 0–4–2 goods engines, built by R. and W. Hawthorn, 1864, for the Glasgow and South-Western Railway, are shown in Fig. 167, and were the first in which the well-known Stirling external characteristics made their appearance. The domeless boiler had Hawthorn's perforated steam pipe. Stirling's first domeless engines of 1860, built by Sharp, Stewart and Co., were arranged differently. The internal steam pipe had eight short vertical tubes, each 1in. diameter, fixed in the upper side immediately beneath the safety valve casing above the firebox. The upper ends of these short tubes were open to admit steam to the main pipe. These earlier engines

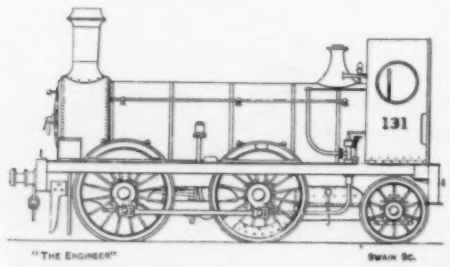


FIG. 167—GOODS ENGINE, G. AND S.W. RAILWAY, 1864

were without cabs. In the engines illustrated, the regulator was of the gridiron slide type, placed in the smoke-box with a double-armed vertical pull-out handle. The trailing end was carried on a single laminated transverse spring. The tires of the coupled wheels were of steel, but those of the trailing wheels were of wrought iron. There was one pump and one injector. The cylinders were 16in. by 22in.; coupled wheels, 5ft.; and trailing wheels, 3ft. 6in. diameter; the boiler contained 162 2in. tubes, pitched at 2⅜in. centres; heating surface of tubes, 852 square feet, of fire-box, 78 square feet, total 930 square feet; pressure, 120 lb. per square inch.

Six-coupled Goods Engines.—Fig. 168 shows the engine sent by Sharp, Stewart and Co. to the London Exhibition of 1862, and afterwards exported to Egypt. Six similar engines were built for the London, Chatham and Dover Railway. It is illustrated to show the solid slotted-out outside plate frames, a design immediately afterwards adopted by M. Kirtley on the Midland Railway. The inside frames extended from front to back buffer beams, whereas in Kirtley's

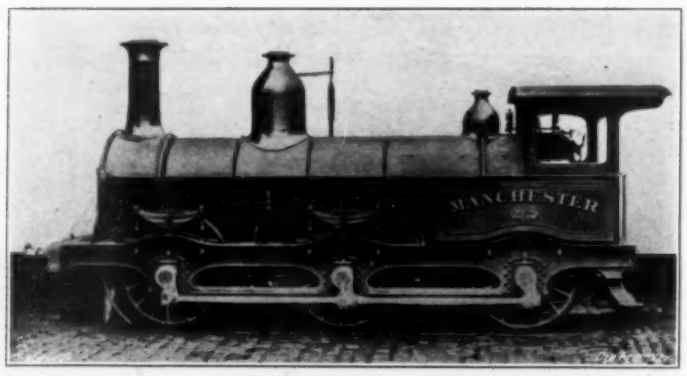


FIG. 168—GOODS ENGINE BY SHARP, STEWART AND CO., 1861–2

engines of 1863–5 they stopped short at the fire-box, and retained the old defect of causing the draw-bar pull to be transmitted through the latter.

Sharp's engine had 17in. by 24in. cylinders, 5ft. wheels, and 120 lb. pressure; wheel base, 15ft. 6in., equally divided. The fire-box was of the Cudworth type, with long sloping grate and two fire-doors; grate area, 27.5 square feet; total heating surface, 1192 square feet; weight of engine in working order, 32 tons.

One of Kirtley's Midland engines of the 1863–9 period, with 5ft. 2in. wheels and 16½in. by 24in. cylinders, was illustrated in THE ENGINEER of November 23rd, 1923, page 549, Fig. 7. From 1860 onwards the Midland engines carried 140 lb. pressure.

A large number of the North-Eastern six-coupled engines of E. Fletcher's designs had double frames and all wheels in front of the fire-box. They had 5ft. wheels, 16in. by 24in. cylinders and 130 lb. pressure. They were intended for long-distance coal trains, but despite the short wheel base were very frequently to be seen on fast main-line goods trains. The outside framing was of the then somewhat antiquated type, with horn-plates bolted on. The majority of these engines were built by Hawthorn and Stephenson, 1860 to 1866, and a number were also constructed by other firms and at Gateshead Works.

An extraordinary type of six-coupled tender engine, considering the period when it was built, is that shown in Fig. 169. It was supplied to the Llanelly Railway by Messrs. Fossick and Hackworth, of Stockton, in 1864 (not 1844 as was erroneously given in J. Tomlinson's address before the Institution of Mechanical Engineers in 1890). The Hackworth, who was a member of this firm, was Thomas, the brother of Timothy, and the engine illustrated was the last design of the Hackworth school, in so far as the steeply inclined cylinders attached to the smoke-box were concerned. The long connecting-rod which drove the trailing wheels, and the rectangular steam chest above the cylinders with very long valve rods, were amongst the peculiar features of this engine. The valve motion appeared to be a form of John W. Hackworth's radial gear, according to the writer's recollection, but unfortunately no sketch of it was made which could definitely settle this point. The engine was preserved for many years at Swindon as a curiosity. It had 16in. by 24in. cylinders and 4ft. 6in. wheels.

Tank Engines for Steep Gradients.—For the Lickey incline on the Midland Railway, M. Kirtley in 1860–3 built some 0–6–0 back tank engines with double frames. The design was generally similar to that of the tender goods engines, but the coupled wheels were only 4ft. 2in. diameter. The inside cylinders were 16½in. by 24in.; pressure, 140 lb. per square inch; and the weight in working order, 35 tons. They were tested, unbanked, with a load of 140 tons up the 2 miles of 1 in 37.

Similar engines were designed by Joseph Tomlinson for banking on the Navigation incline of the Taff Vale Railway, on which the gradient was 1 in 20. These engines, which were built by Sharp, Stewart and Co., 1865–7, had saddle tanks, 16in. by 24in. cylinders, 4ft. wheels, and 130 lb. pressure.

Eight-wheels Coupled Tank Engines.—The two most powerful tank engines in this country were to be found in the Vale of Neath Railway. They had eight coupled wheels and outside cylinders, and were built in 1864 by the Avonside Engine Company, of Bristol. The illustration—Fig. 170—shows one of two very similar engines built by the same firm in 1866 for the Great Northern Railway, on which line they were employed in the King's Cross goods yard, and in working through the Metropolitan tunnels. For this service the latter engines were fitted with condensing apparatus. The cylinders were 18½in. by 24in., and the diameter of the wheels 4ft. 6in.; the wheel base of the Vale of Neath engines was 4ft. 10in. + 4ft. 10in. + 5ft. 7in. = 15ft. 3in., and the side tanks were considerably shorter than those of the G.N.R. engines. The latter had a wheel base of 15ft. 10in., the distance between the centres of the second and third pairs of wheels being increased to 5ft. 5in. The boiler barrel of the V.N. engines was 13ft. 1½in. long by 4ft. 2$^{3}/_{16}$in. diameter inside at the front ring, and 4ft. 5in. diameter at the back ring; fire-box casing, 7ft. long by 3ft. 10in. wide; 203 2¼in. tubes gave a heating surface of 1588 square feet, to which the fire-box added 155 square feet; total, 1743 square feet; grate area 23.8 square feet; pressure, 140 lb. The G.N.R. engines had longer boilers and shorter fire-boxes, and the number of tubes was reduced to 184 2¼in. diameter. The total heating surface was 1550 square feet.

The fire-boxes had longitudinal partitions and transversely placed roof girder stays. The cylinders were spaced with centres 6ft. 9½in. apart, and the steam chests were let through holes in the frames. Gooch's stationary link motion was used, the links being placed in front of the second axle, the excentric rods passing one above and the other below this axle, The radius rod passed below the leading axle, and was deeply cranked to clear it. The connecting-rods were 9ft. 5in. long. The total weight of the engines was 56 tons.

The tires of all wheels had flanges, but the leading and trailing axle-boxes had a lateral movement in the guides of ⅛in. on each side, controlled by a special arrangement of check springs, the invention of M. Caillet, a French engineer, which will be described subsequently.

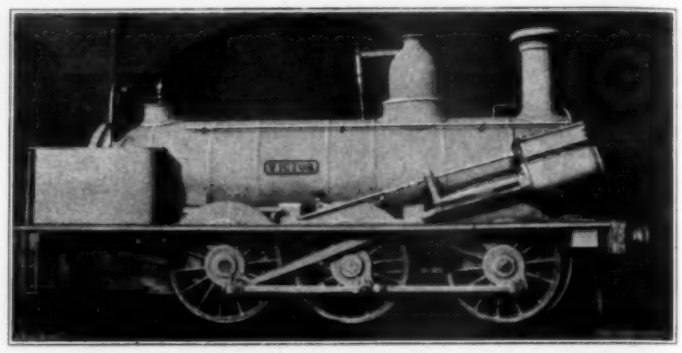


FIG. 169—FOSSICK AND HACKWORTH'S GOODS ENGINE, 1864

Whether these were the earliest eight-coupled engines actually used in this country is not quite certain. Clark ("Railway Machinery," 1855) shows a diagram of an eight-wheels coupled tender engine by Stubbs, of Llanelly, with 3ft. wheels and 9ft. 6in. wheel base, but gives no information beyond stating that it was designed to run on mineral lines in Wales. The writer has not been able to trace this engine, which, if it ever got beyond the stage of a design only, must have been built between 1850 and 1853. There was another eight-coupled tank engine, with 20in. by 24in. cylinders and 4ft. 9in. wheels, on the Llanelly Railway, stated to have been built in 1865. Including it, but exclusive of the engine shown by Clark, the above five tank engines were the only representatives of the eight-coupled type on British railways for many years, and all were scrapped before the end of 1880.[2]

Sturrock's Steam Tenders.—A full account of these tenders with drawings and complete specification, appeared in THE ENGINEER, January 17th and May 9th, 1919, so that it is not necessary to give more than the briefest particulars. The six wheels of the tender were coupled through outside cranks, and two 12in. by 17in. inside cylinders were placed underneath at the front end, the middle axle being cranked to take the drive. Stephenson's link motion was fitted. Steam from the boiler of the locomotive was taken from a second regulator in the dome through an external pipe to the tender, and probably had a considerable percentage of moisture in it by the time that it reached the tender cylinders. The exhaust passed into a tubular condenser in the bottom of the tender, and heated the feed water, after which it made its exit to the atmosphere through a short chimney at the back. The engines fitted with these tenders were capable of hauling heavy coal trains between Doncaster and London, *viâ* Lincoln, but burnt a large amount of fuel. There was also the difficulty of maintaining steam in a boiler of moderate dimensions. The drivers were stated to have disliked them exceedingly, as they had the equivalent of two engines to look after, and the heat on the foot-plate was excessive. These tenders were first tried

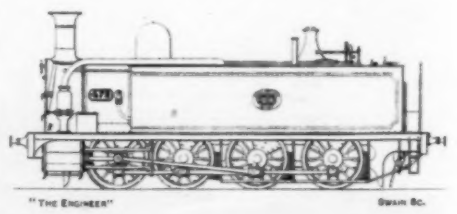


FIG. 170—TANK ENGINE BY THE AVONSIDE CO., 1864–6

experimentally in 1863, and a considerable number were built in 1864–6, but P. Stirling, who succeeded Sturrock on the G.N.R. in 1866, shortly afterwards converted them to ordinary tenders. The Manchester, Sheffield and Lincolnshire Railway also had a number, which met with a similar fate.

Sturrock was not the first engineer to adopt a steam tender, the credit for which was due to M. Verpilleux, who constructed one in 1843 for the Lyons and St. Etienne Railway.

The Fairlie double bogie tank locomotive and the Fell central rail engine also made their first appearance during this period. Engines of these types will be considered later.

PRELIMINARY statements concerning New South Wales manufactories show that for the year ended June 30th, 1924, there was an increase in number of 614 and increases of £3,244,273 and £3,469,271 in the value of land and buildings and plant and machinery respectively. Value of materials used increased by £7,847,465 and output by £12,968,897, while the value added to materials by the processes of treatment advanced by £4,030,978. Wages paid exceeded by £2,614,735 the previous best figures.

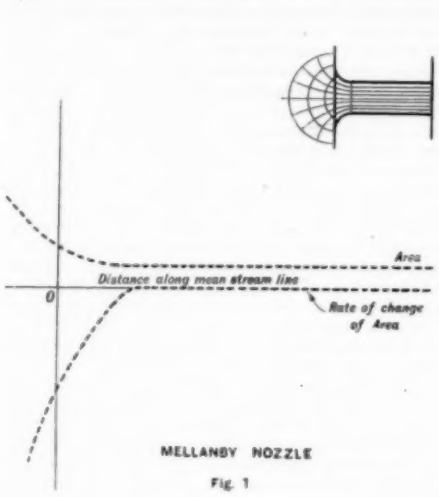
[2] Figs. 159 and 169 above are from photographs by Mr. R. E. Bleasdale, Warwick, and Figs. 163 and 164 by the Locomotive Publishing Company, Ltd., London.

Steam Nozzle Research.

AT a meeting of the North-Western Branch of the Institution of Mechanical Engineers, which was held at the Engineers' Club, Albert-square, Manchester, on Thursday, May 7th, the fourth report of the Steam Nozzle Research Committee, of which an account was given in THE ENGINEER of May 8th, was discussed.

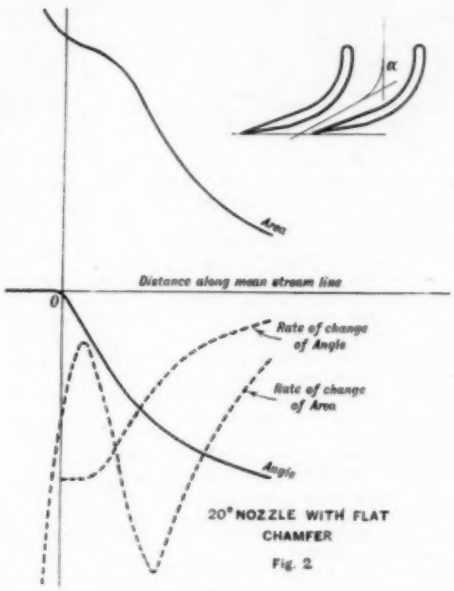
Mr. Baumann, who was unable to attend, sent in a communication, which was presented by Mr. I. V. Cox. Mr. Baumann wrote that in judging the importance of the report and the possibility of applying the results to actual turbine practice, one had to keep in mind the fact that the tests did not necessarily show the correct efficiencies of nozzles when working in turbines. For instance, it was probable that the form of the jet, *i.e.*, the stability of the jet, or the uniformity of the efflux angle over the exit area, had a considerable influence on the efficiency of a turbine stage. In the tests as carried out by the Committee, it was unlikely that the impact was influenced to any extent by either the stability or the uniformity of the jet owing to the considerable distance between the jet exit and the impact plate. In actual turbines, that distance was of the order of ¼in. to ½in. measured along the jet, whereas in the nozzle tests it was several times as large. It followed that the correct comparison of relative nozzle efficiencies could be obtained only when working with moving blades in an actual turbine stage. Until the relation of nozzle efficiencies tested under the two conditions was ascertained, turbine designers should be careful in applying to actual practice test results as obtained on the nozzle tester. There was no doubt that the relatively higher efficiency from the work contained in the report that the discharge coefficients relating to the 12 deg. thin plate nozzle showed two types of flow with a break in between somewhere in the region of 700–900ft. per second. The thick plate nozzles did not show that at all. Although the results had been worked out, no definite assumptions had been arrived at. He thought it seemed to indicate that in the case of the thin plate nozzle there was some sort of effect beyond the nozzle, and that perhaps for that reason the thick plate nozzle would be desirable, and the efficiency would be sufficiently raised by chamfering to make it equal to the efficiency of the thin plate nozzle. It should be observed that the elementaty nozzles—the so-called Mellanby nozzles—and also the single elementary nozzles, did not show that effect. The curve in their case was perfectly continuous throughout.

Mr. Norman Elce said that, by the courtesy of Professor Stoney and the Committee, he had been enabled to test two of the Committee's nozzles in the nozzle tester at Metropolitan-Vickers. They were the 20 deg. impulse nozzles with 0 to 1 throat and flat chamfered exits—Fig. 4 of the third report—and the straight elementary Mellanby nozzle consisting of seven ¼in. diameter nozzles—Fig. 12 of the third report. The two sets of nozzles were lent to the Metropolitan-Vickers Company together with the corresponding nozzle pipes, and were tested together precisely as at Dickinson-street; since the two nozzle testers were similar in type and differed only slightly in dimensions, one would expect equal results. Hence it was rather disconcerting to find a persistent difference—amounting to about 1 per cent. in the velocity coefficient, that is, about 2 per cent. in efficiency over most of the velocity range—in the case of the impulse nozzle. At first sight it seemed possible that the difference instance, a list might be made such as :—(1) Approach to the nozzle; (2) shape of cross section of nozzle; (3) surface finish; (4) form and rate of convergence; (5) curvature of nozzle axis; (6) dimensions; and no doubt others. There remained the questions of convergence and of curvature. To illustrate this point, the speaker exhibited slides showing curves for the Mellanby and the 20 deg. impulse nozzle. They are reproduced in Figs. 1 and 2, and in Fig. 3 are shown superimposed. These two sets of curves did not, of themselves, lead to any precise conclusion. But it was obvious that nozzle efficiency was bound up with the values represented in the curves considered both independently and in relation to one another—that was to say, the best efficiency might, for instance, be given when the maximum rate of change of curvature coincided with the maximum rate of convergence. Expressed in another way, the best condition might be that which existed when a certain rate of change of curvature coincided with a particular rate of acceleration of steam speed. If the idea was worth developing its value depended on the amount of data brought to its examination; it might even repay special tests. The curves contained nothing which was not also present in the drawing of the nozzle section; in fact, they contained less; but they had the merit of showing clearly and independently certain variables which only the most expert eye could otherwise distinguish. He suggested that a further curve might be added to show the corresponding steam velocities along the nozzle—that could be done at least approximately. The importance of curvature might be emphasised by reference to the general shape of the φ curves corresponding to different nozzle angles. For straight nozzles and 20 deg. nozzles the curves showed a decided rise at low velocities which was absent in the case of



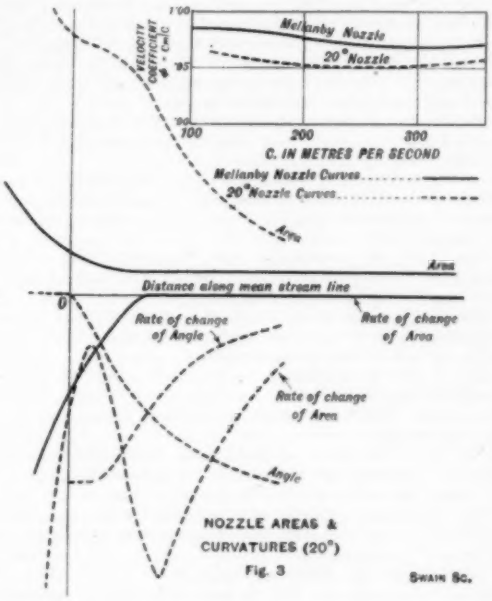
MELLANBY NOZZLE

Fig. 1



20° NOZZLE WITH FLAT CHAMFER

Fig. 2



NOZZLE AREAS & CURVATURES (20°)

Fig. 3

"THE ENGINEER" SWAIN Sc.

of the built-up nozzle was largely due to the better finish of the nozzle consequent on it being machined throughout. The use of machined nozzles for intermediate diaphragms depended largely on the price which turbine users were prepared to pay for the highest efficiency. Undoubtedly before the war machined nozzles throughout the turbine would not have been justified, but in view of the present high cost of fuel manufacturers were prepared to quote for turbines in which the nozzles, at least in the horse-power end, were machined, thus securing the highest efficiency for some 50 per cent. of the total heat drop. There was no doubt that an improvement in efficiency could be obtained in that way.

Mr. Ashworth dealt with some of the calculations employed in the preparation of the report, some of which had been worked out by him and students mentioned in the report.

Mr. Newton said that he would confine his comment to one point only, and it seemed to him that that point was one of considerable practical importance from the point of view of turbine manufacture. The Committee had found that the efficiency of nozzles formed with thin plates could be equalled by nozzles formed with thick plates provided the edges were chamfered. That was a simple result, and was one which gave the designer an immense amount of freedom in designing nozzles of high efficiency. Efficiency was not the only point a designer had to attend to. Frequently, he had to design nozzles which were mechanically strong and resistant to corrosion, and the fact demonstrated by the Committee that thick nozzles could be used provided they were chamfered gave him very great freedom. The practical result was that it was possible to make turbines which were efficient and mechanically good.

Mr. E. W. Beeley said that he would like to say one thing in reference to the last speaker's remarks on the subject of making a stronger nozzle. It appeared between the Committee's results and the Metropolitan-Vickers' results might be due to some systematic peculiarity of one or both of the instruments. On the other hand, the test results for the Mellanby nozzles were almost identical over most of the velocity range. It would appear, therefore, that there is a systematic error in one or other of the impulse test series, or else that the conditions of flow are different, and lead to different values of the velocity coefficient for different cage dimensions in the case of the impulse nozzle, but not for the elementary nozzles in which the arrangement of metal masses within the cage is symmetrical. In that event one would expect the velocity coefficient to vary with the distance between the nozzle and the impulse plate, but it does not, even for a large variation, either with the Dickinson-street or the Metropolitan-Vickers testers. The initial pressure was measured in duplicate with very good agreement; the initial temperature reading was also duplicated, the readings of the platinum resistance thermometer being checked by a mercury in glass thermometer; these readings also agreed very closely. The weighbridge for the consumption measurement was calibrated before and after each day's testing; the leverage of the balance arm of the tester was checked by weighing and found to agree with the dimensional leverage to within 1 in 1000; and the balance of the balance arm was checked frequently during the tests. Continuing, Mr. Elce said that the programme now completed contained wide variations of design, such as nozzle angle and length of parallel throat, representing probably about the commercial limits for convergent nozzles, and the value of the tests would be very much enhanced if they could in some way be rationalised as manifestations of natural law. No means should be ignored which held out even the distant prospect of such an end. Various quantities had been enumerated from time to time as being factors which were more or less distinct and capable of individual consideration. For the 12 deg. nozzle. But that rise took place at a lower velocity in the case of the 20 deg. nozzle than for the Mellanby, and presumably if the 12 deg. nozzle could be carried to a sufficiently low velocities, the rise would appear in that curve also. It would seem that curvature was most important in promoting turbulence; viscous flow was not maintained in fine angle nozzles to velocities as great as is the case with coarse angle nozzles; and the curve was consequently moved bodily downwards and to the left.

Mr. Telford Petrie said that the report which had been presented that evening might be regarded as the close of the first part of the work of the Committee. With regard to absolute variables, the suggestion had been made that the efficiencies, as such, were not really of great value to the designer. The researchers did not consider that they were getting absolute valuation; they hoped they were getting relative valuation. They had tried to have only one variable at a time; they had tried to be consistent. The only uncontrolled portion had been the superheat, and that had been dealt with in the report as far as it could be. With regard to instability, which had also been mentioned by Mr. Baumann, and throat length—there one got a multiplication of variables. He did not think instability was due to any one cause. The Committee felt that the instability was due to the combination of lack of throat and the blow through. The question of finish had been mentioned several times, and was a very debatable point. There were some researchers and people who were studying problems very deeply, including manufacturers, who placed a great deal of reliance on finish. He himself had been disappointed in the results that had been obtained from finish. He did not know that the finish had shown the improvement it should have done. When they came to the question of analysing the facts, and getting out nozzles step by step, as Mr. Elce had suggested with different curvature effects and so on,

it was very difficult indeed to get one variable without having to upset other dimensions as well. The steam did extraordinary things between the entrance and the exit, and he did not believe that they really knew very much about what was happening, particularly round about the point where some of the curves dipped. There seemed to be a disturbing influence at work, of which, so far, one could not say that a definite explanation had been given.

Professor G. G. Stoney said that the results obtained by the Committee should only be taken with a certain amount of caution by turbine designers. He thought, however, that the knowledge that thick plates were as good as thin would probably be of considerable value. As Mr. Newton had remarked, it gave much more mechanical strength. The idea of chamfering the nozzles of thick plates was originally due to Mr. Frederick Samuelson.

Iron and Steel Institute.

No. II.*

THE concluding session of the annual spring meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers on May 8th, under the presidency of Sir Frederick Mills.

The secretary announced that the following awards had been made in connection with the Carnegie Research Scholarships :—

Mr. Walter Crafts, of Reading, Pa., U.S.A., £100, to assist him in carrying out a research on the production of carbonless chromium by the method of leaching and electrolytic deposition of chromium from chromite.

Mr. William H. Dearden, Royal School of Mines, South Kensington, £100, to carry out an investigation on the specific heat of iron below 400 deg. Cent.

Mr. Thomas Henry Turner and Mr. Eric W. Fell, of the University, Birmingham, £100 jointly, to investigate methods of detection and the nature of permanent deformation or strain in steel.

Mr. Robert Higgins, of Glasgow, £100, to study the volume changes in cast iron brought about by repeated heating and cooling.

Mr. Hugh O'Neill, the University, Manchester, £100, to investigate the nature of hardness in relation to cold working and machining properties of metals.

Mr. John H. Partridge, the University, Birmingham, £50, to continue study of the electric and magnetic properties of cast iron.

Mr. Leonard Bessemer Pfeil, University College, Swansea, £100, to continue studies of the growth of large crystals by annealing strained iron.

Mr. Cecil H. Adamson, of Sheffield, and Mr. Gerald S. Bell, of Lincoln, £50 jointly, to continue research on cast iron transverse test bars and engineering formulæ.

Mr. David W. Berlin, of Stockholm, Sweden, £50, to continue study on the specific gravity of liquid iron and steel and other metals of high melting point.

Mr. Algernon L. Curtis, of Chatteris, Cambridge, £100, for research on steel moulding sands and their behaviour under high temperature.

Mr. Edgar R. Taylor, Municipal Technical School, Birmingham, £50, to continue studies on the effect of manganese and sulphur on the mechanical properties of white-heart malleable cast iron.

A paper was presented by Mr. R. H. Greaves and Mr. J. A. Jones dealing with "Temper Brittleness in Steel with special reference to Temper Brittleness in relation to Chemical Composition," and another contribution was submitted by Mr. W. T. Griffiths on "Nitrogen as a Factor in Temper Brittleness." The two papers were the subject of a joint discussion.

TEMPER BRITTLENESS OF STEEL.

The susceptibility of a steel to temper brittleness is measured by the ratio of the impact figure of a sample rapidly cooled after tempering to that of a sample slowly cooled, the previous history being the same in each case. The following procedure was adopted as the standard test for susceptibility. Two similar samples of the steel were taken, oil hardened from 900 deg. Cent. and tempered for two hours at 650 deg. Cent. One sample was cooled in water after tempering, and the other cooled slowly, the rate of cooling between 600 deg. and 400 deg. Cent. being uniform and 0.3 deg. Cent. per minute. The ratio of the impact figures of these samples was taken as expressing susceptibility under standard conditions. If 650 deg. Cent. too nearly approached the critical range of the steel, a slightly lower tempering temperature was employed.

Susceptibility to temper brittleness is shown by the series of experiments described, and by other work, to be markedly influenced by differences in composition. Phosphorus and manganese increase susceptibility, and when they are present in any amount beyond a small percentage the increase is very pronounced. Silicon and vanadium have a slight effect, and tungsten no appreciable effect, in increasing susceptibility, when present in percentages likely to be met with in commercial steels; but it seems clear that none of these three elements will inhibit temper brittleness. Molybdenum, on the other hand, has a very pronounced effect in reducing susceptibility, and a small percentage of molybdenum—about 0.3 to 0.5 per cent.—counteracts the influence of high phosphorus and manganese in this respect, and renders steels which are normal in composition as regards these elements non-susceptible. More extended use of molybdenum is a means, and may prove to be the best method, of overcoming difficulties associated with temper brittleness.

Susceptible steels may, in other respects, be very satisfactory, and after proper treatment may show excellent mechanical properties. Such, for example, are the high-manganese carbon steels, and nickel-chromium steels with relatively high carbon and chromium content. Yet in these steels, air cooling of fairly large masses from the tempering temperature may often give rise to very low impact figures. The undesirable temper-brittle condition may be avoided by cooling in water from the tempering temperature, but objections have been urged to this procedure on the ground that severe internal stresses are produced. Such stresses may be avoided by the use of a somewhat slower rate of cooling, such as quenching in oil, in which the rate of cooling is considerably checked before the steel cools below 300 deg. Cent., or they may be relieved without detriment to the properties by re-heating to a temperature of 400 deg. Cent.

* No. I. appeared May 15th.

NITROGEN AND TEMPER BRITTLENESS.

It has been pointed out by certain investigators that in a steel which exhibits susceptibility to temper brittleness, different magnetic properties may be associated with the high and the low notched bar impact figures shown by the steel after quick and slow cooling from the tempering temperature. While considering the possibility of using the rate of change of some magnetic property with change of temperature as an indication of the position of the so-called "embrittling range" in temper-brittle steels, the author was struck by the fact that steels containing nitrogen were said to show magnetic changes at a somewhat similar temperature to those stated to mark the beginning and end of this range.

Further investigation showed that after increasing the nitrogen content in certain steels which were non-susceptible to temper brittleness, an effect could be produced on the impact figure of the steel by quickly or slowly cooling from 630 deg. or 650 deg. Cent., which was apparently identical with that characteristic of temper-brittle steels. A carbon steel of the composition—

	Per cent.
Carbon	0.39
Silicon	0.093
Manganese	0.57
Sulphur	0.020
Phosphorus	0.025
Nitrogen	0.004

and non-susceptible to temper brittleness was used for the first experiments. After hardening from 900 deg. Cent. and tempering at 650 deg. Cent., specimens quickly and slowly cooled gave impact figures of 52 and 50 respectively.

The fractures of all specimens containing nitrogen which were water-cooled after tempering were fibrous, but those of the slowly cooled test pieces were of the usual bright granular type of temper-brittle material. No differences were observed in the microstructure of test pieces giving the higher and lower impact figures, and the Brinell hardness numbers of the two are similar.

Attempts to introduce nitrogen into alloy steels other than a nickel steel have, up to the present, been unsuccessful. The rate of diffusion of nitrogen into these steels at any temperature suitable for nitrification with ammonia is extremely slow—hard, highly nitrified surface layers forming without the centre of the specimen being affected.

It, however, appears from what has been done that nitrogen may in certain circumstances exert an important influence on the susceptibility of a steel to temper brittleness.

Dr. W. H. Hatfield said that it should be clearly understood that the results described in the first paper only applied to steel in the notched bar condition. The work done must be regarded as a serious contribution, but he would have preferred the experimental evidence to have been amplified in one or two directions, notably by the addition of the Brinell test. Variations in the impact figures were the result of heat treatment. He was inclined to question whether the relation between temper brittleness and composition was as simple as the authors had suggested. The addition of a small percentage of molybdenum did not invariably have the effect of keeping the impact figure constant, and it did not in any event produce a high impact value. Nor should it be overlooked that molybdenum was a very expensive material, and a recommendation for increased use of it raised an important industrial question. Only in exceptional cases, when high-tensile strength in association with considerable ductility was required, was the use of molybdenum justified. The information given by Mr. Griffiths as to the effect of nitrogen would be valued, but the nitrogen content in commercial steel would not be of an order to have any influence on the mechanical properties of the material.

Mr. Griffiths said that he could not agree that the nitrogen content in commercial steel was of negligible importance.

A paper by Mr. D. H. Ingall and Mr. H. Field, "Peeling in White-heart Malleable," was then presented for discussion.

"PEELING" IN WHITE-HEART MALLEABLE.

The phenomenon of "peeling" with which this paper deals, is a defect well known both to malleable ironfounders and machinists, being met with frequently in the manufacture and use of malleable cast iron. Castings suffering from this defect present a normal outward appearance, but the fracture after breaking reveals an inner core, surrounded by one or more layers of "skin" or "peel," these layers being so loosely attached to the core and to one another that either they become detached in the breaking or can be removed by a few blows with a hammer. The remaining core then presents a smooth surface, and has generally the same contour as the original specimen. The mechanical properties of the metal are not greatly affected by the presence of this internal defect, except in cases in which it may be very pronounced, notably thin plates, in which the core may be entirely absent and the metal a series only of "skins."

The influences effecting the production of peel may be summarised as follows :—

(1) Metal containing sulphur between approximately 0.20 and 0.40 per cent. will be liable to peeling, and the higher the silicon content the greater will be the liability.

(2) Temperatures in the neighbourhood of 930 deg. Cent. are most conducive to peeling. Higher and lower temperatures, though they do not necessarily prevent the formation of peel, retard its growth. With lower temperatures there is, of course, the risk of the material not being completely malleabilised, and with higher temperatures the possibility of burnt metal resulting.

(3) The faster the rate of heating to the annealing temperature, the greater by far is the liability to produce peeling.

(4) "Peel" has been found to consist of a layer or layers of ferrite containing free oxide globules as inclusions. When this layer is once formed it will continue to grow with time, according to temperature conditions—*vide* (2).

(5) The work outlined above has not given any definite proof of the mechanism causing the development of peeling. With the evidence obtained the following view is tentatively put forward :—The formation of peel is the result of oxidation of the metal. There would appear to be an approximate critical temperature between 900 deg. and 940 deg. Cent., above which this oxidation effect may commence. As soon as oxidation begins, the growth of the oxide layer would appear to depend on the result of a race between rate of oxidation and rate of carbon supply by diffusion from the interior. It is for this reason that rapid heating promotes rapid peel growth, as the cementite has not time to dissolve and diffuse at a rate necessary to counteract the penetrating oxidation. The retarding effect of high temperatures will be seen to be due to the more rapid solution and diffusion of the cementite. The authors have no explanation to offer with regard to the *rôle* played by the sulphur content of the material.

Professor Thomas Turner welcomed the contribution as dealing with a question of practical importance. In commercial work the trouble was that impure materials only were available, and not the pure materials at the disposal of the authors for their experiments. He had never been able to understand why for making malleable iron it was necessary to have a material containing about 3.5 per cent. of sulphur. In American practice an iron of much lower sulphur content was employed. Experiments had been made at Birmingham on the effect of sulphur on mechanical properties, and with the sulphur content within ordinary limits no ill effects could be traced. The influence of sulphur in other directions was still somewhat obscure. Sulphur and oxide of iron, as Dr. Percy showed, could exist side by side without any reaction taking place, except at high temperatures. The available knowledge suggested that the acceleration of peeling caused by sulphide of iron was due to the fact that at about the temperature where peeling occurred sulphide of iron was more readily oxidised than the iron. It was also necessary to consider the influence of carbon on the sulphide of iron, and take into account the possibility of some kind of combination between the iron sulphide and the carbon.

Dr. W. H. Hatfield agreed generally with the conclusions put forward in the paper, and he thought that high silicon in association with high temperature was instrumental in producing peeling. There was definite evidence that sulphur silicides could be formed as shown in work done on this subject by Dr. Stead. Professor Turner had said that he could not understand why malleable iron makers used an iron with a comparatively high sulphur content. The point of importance was that the manufacturer wanted an iron low in silicon, and he had been compelled to accept an iron higher in sulphur content than was desired for the reason that it had the right percentage of silicon. In the United States an iron low in sulphur as well as low in silicon content was available.

Professor E. D. Campbell, who expressed his interest in what Professor Turner had said, directed attention to the influence of manganese on the rate of oxidation of iron sulphide. With regard to the effect of time and temperature more experimental work was needed, and an attempt must be made to determine questions of equilibrium at the temperatures used in the manufacture of malleable iron.

Dr. W. Rosenhain raised the question of the eutectics of iron and sulphur and iron and phosphorus, and said that it was necessary to know a great deal more about these complex systems before attempting to lay down conclusions. The addition of another element had the effect of lowering the temperature at which changes occurred in the condition of the various constituents of the metal. The reactions which took place were very complicated and difficult to follow, and theoretical explanations concerning equilibria must be received with caution. It was agreed that the presence of sulphur did not affect the mechanical properties of the iron to any extent, and if it had disadvantages from the point of view of the manufacturer of malleable iron, a cheap method of dealing with it was available.

Mr. W. Field, in concluding the discussion, said that the work undertaken by the authors was designed to assist ironfounders. Reference had been made to the difference in the sulphur content of the iron used for malleable in Great Britain and in America. He would remind the meeting that in British practice the iron was melted in a cupola, while in America the open-hearth furnace was used. With the open-hearth furnace the iron was prevented from coming in contact with the fuel, and it was possible to keep the sulphur content to a low point, which could not be done in cupola practice. The authors were much interested in the information given by Professor Turner. The question of the iron sulphide eutectic was undoubtedly important. On the subject of the mobility of sulphur, to which reference had been made, he and Mr. Ingall were inclined to think that there was considerable movement of sulphur, not only outwards, but within the material. With regard to the presence of manganese, the inference was that metal containing that ingredient could not be malleableised.

The presentation of a paper by Mr. R. L. Smith and Mr. G. E. Sandland, "Some Notes on the Use of a Diamond Pyramid for Hardness Testing," opened up a discussion on methods of testing for hardness.

THE DIAMOND PYRAMID FOR HARDNESS TESTING.

In an endeavour to increase the accuracy and reliability of plastic indentation hardness tests, the authors decided to investigate the possibilities of a diamond, cut to the form of a square-based pyramid, in place of such well-known indenters as the steel ball, steel cone, &c.

This investigation has been limited by the size of the diamonds to small impressions, and consequently to loads not exceeding about 100 kilos. It was found, however, that these small impressions were very satisfactory, as they were not only economical on account of the small diamonds required, but the correspondingly small loads enabled the diamonds to have a very

long life. The formula adopted for obtaining the hardness numeral is—

Load ÷ Impressed area,

which is, of course, identical with the well-known formula used in the Brinell test.

Experiments were carried out on a given homogeneous test piece with a number of pyramids of different angularities, and, as might be expected, the hardness numerals varied accordingly. It was found, however, that the hardness numerals obtained with any given pyramid were practically constant, irrespective of the load applied.

The similarity in the hardness numerals from pyramid and ball impressions obtains only in the lower regions of hardness—that is, where the steel ball does not undergo any appreciable deformation. At approximately 525 Brinell hardness there is a very slight but definite tendency for the steel ball to yield lower readings than the diamond pyramid, and this tendency increases with increase in hardness until it becomes very pronounced indeed.

From the authors' experiments, it would seem that the diamond pyramid promises well and merits further investigation as an indenter in hardness testing.

Professor Turner said that the determination of hardness in very hard material was a subject of great importance to the steel manufacturer, and was attended with much difficulty. The difference between grades of hardness at the lower end of the Brinell scale was easily determined, but at high numbers accurate determinations could not be obtained, and other methods than the Brinell had been tried. He had experimented with the scratch test, and had endeavoured to correlate the results obtained with the Brinell figures, but found with increasing hardness that even when using very high magnifications it was difficult to measure the width of the scratch. The results of recent work were given in a paper presented to the Institution of Mechanical Engineers, but he did not entertain any great hope that the scratch test would give accurate quantitative values for very hard materials. Another method was required to supplement the Brinell test in the higher ranges, and the work done by the authors suggested that perhaps more accurate hardness results could be obtained by their method than by the tests now in use where very hard materials were concerned.

Sir Robert Hadfield, while expressing his interest in what had been done, said that he thought the best line of work would be to search for an improvement of the Brinell test for very hard materials, as that test was now in common use. It was necessary to determine the character of the hardness as well as the absolute hardness of materials. It was quite possible to have two steels, each of the same Brinell hardness number of 650, but which might show definite differences in properties after treatment. The Brinell test did not reveal the quality of toughness, nor would the method described in the paper bring out that property. He would recall to the Institute the fact that the British Engineering Standards Association was now engaged, among other tasks, in an attempt to standardise hardness numbers given by the Brinell test. The authors should put themselves in touch with the Committee engaged on that work. What the Committee had in view was the standardisation of the expressions used to indicate hardness, and it would be a great service to industry if the hardness numbers could be made comparable on a world basis. There was at the present time some uncertainty as to the use of hardness numbers in different countries. He thought that the diamond pyramid method should be submitted for the opinion of Dr. Unwin.

Mr. Hugh O'Neill referred to the importance in testing for hardness of the rate of loading and the time for which the load was applied. An examination of the results given by the authors pointed to the need of laying down conditions for testing cold rolled material if variations in the results obtained by different workers were to be avoided. In soft and annealed materials the indentation was of a different character from that produced by the test on cold-worked materials, but it appeared that it was possible to determine by the method described in the paper the hardness of the different constituents of steel. Satisfactory use could probably be made of the diamond pyramid test if the method of using it were standardised.

Mr. A. Hultgren thought that the new test for hardness would be very useful and convenient. The authors had fixed a scale of hardness by keeping the angle of the pyramid constant, and probably they were justified in the contention that by so doing they obtained the ball hardness figures which would be given if a constant relation were maintained between the size of the ball and the size of the indentation. That was not the original definition of the Brinell test, and it must be kept in mind, therefore, that the results obtained by the diamond pyramid test did not represent Brinell figures.

Professor Henry Louis commented on the difficulty with the diamond of grinding an angle to a very high degree of accuracy. He would point out that the natural crystal diamond was an octohedron, and that a natural constant angle could be obtained, and that under pressure the cleavage lines were along octohedral planes. By using a pyramid of the natural angle one difficulty would therefore be overcome. There was another material which might be used for hardness testing by the ball method. He referred to the opaque Ceylon sapphire. It gave a very true sphere, and was not liable to fracture, and it occurred to him that the sapphire ball might enable the differences between the pyramid and the Brinell test to be reconciled.

Mr. A. B. De Forest said that manufacturers in the United States had used the diamond indentation principle for testing hardened tool steels and other materials with satisfactory results. Instead of measuring the diameter of the impression, the difference between the depths at varying loads was measured, and that was done quite quickly. An advantage was that examination of the tested material under the microscope indicated by the character of the indentation whether the material had been cold worked or subjected to other treatment.

Dr. Samuel Hoyt drew attention to the advantages of a method of testing which produced a geometrically similar impression for all loads. Professor Meyer had shown that the property of hardness could not be indicated by any one figure. Compared by the Brinell test, cold-worked copper appeared to be harder than mild steel, which was not the case. To obtain complete information it was not only necessary to know the hardness at one empirical point, but to have hardness curves for the complete range of loads. With regard to the ball, the Bureau of Standards had decided, as the result of recent tests, that the tungsten carbide ball was not deformed by steel having hardness numbers of 700 Brinell, and it was clearly an ideal ball for using with the Brinell test. He agreed that it was desirable to retain this test and to work for its improvement.

Mr. T. H. Turner said that compression tests and tension tests on mild steel showed that 45 deg. was a fundamental angle for the material. He would like to ask whether the authors had made tests at that angle, and whether their results gave figures which were comparable with the tensile and compression results. The Brinell figures were nearly comparable.

Owing to lack of time, the authors could not reply verbally, but in their written comments on the discussion they say:—With reference to Professor Turner's remarks regarding the difficulty of measuring small scratches and small impressions obtained by the ball Brinell method, no difficulty was presented in measuring the diamond impressions accurately to .002 mm., which on the hardest of steels amounts to an error of about 1.5 per cent. In reply to Dr. Hoyt and Mr. Axel Hultgren, they say that there appears to be every reason for assuming that the diamond pyramid numerals are identical with those which would be obtained with constant-sized impressions obtained with a polished diamond ball. With regard to Mr. Hugh O'Neill's remarks concerning the somewhat higher numerals obtained with the diamond pyramid at very low loads on copper and certain other soft materials, they had found it to be caused by the surface hardening produced in preparing the specimen for test. The pyramids referred to in the paper were in every case cut with the natural point as a foundation, and it was found that by so doing the final pyramid could be finished to a most excellent polish. In using pyramids so cut, there appeared to be no indication whatever of splitting along the cleavage planes. Although in the initial stages the accurate cutting of the diamond presented many obstacles, after considerable experimental work those difficulties had been entirely overcome. Experiments had been carried out with sapphire balls, but, in addition to the disadvantage attendant upon the use of a ball, it was found that they crushed very easily, even under light loads.

A paper by Mr. T. H. Whiteley, entitled "Observations on Martensite and Troostite," and one by Mr. B. D. Enlund on the "Structure of Quenched Carbon Steels," were taken as read.

MARTENSITE AND TROOSTITE.

The observations recorded in this paper were made during the course of an investigation, the aim of which was to trace the origin of the different structures grouped under the term martensite. As the work progressed, it soon became obvious that before the results could be interpreted with any degree of confidence, the formation of troostite and its subsequent behaviour in tempering would also have to be considered. For this reason the name of the latter constituent is included in the title of the paper. The inquiry was confined entirely to the microscopic examination of various quenched specimens, and while the facts thus derived seemed of sufficient importance to justify their presentation, it must, nevertheless, be admitted that much still remains obscure. On the subject of the intense hardness of martensite, the research afforded little, if any, fresh evidence; indeed, it is very doubtful whether a solution of this problem is possible by the aid of the microscope alone, and, consequently, no reference is made to the many theories of hardening. For convenience, the effects obtained are discussed under two main headings, namely, quenching effects and tempering effects. At least four types of martensite are distinguished, and the results show that the changes which occur in tempering lend support to this classification.

QUENCHED CARBON STEELS.

It is a well-known fact that plain carbon steels high in carbon have a partially austenitic structure when sufficiently intensely quenched. Martensite needles are here embedded in a ground mass of austenite. If this steel be annealed, the martensite needles are transformed into troostite, the reaction being most marked at a temperature somewhat above 100 deg. Cent. The austenite, however, does not change until the temperature is raised to about 260 deg. Cent. If the steel be of low or medium carbon content, it does not present this distinct two-phase structure, even if it be quenched from a very high temperature. In a mild steel quenched from 960 deg. and 1100 deg. Cent., the structure is very indefinite, and it is impossible to discern if it be formed of more than one phase. That some of the γ-iron is preserved at ordinary temperature, even in such steels, may, however, be gathered from some investigations by the author dealing mainly with the change in electrical resistivity and specific volume with annealing temperature. The results thus obtained indicate also that it is not even necessary to quench mild or medium steels at an unusually high temperature to retain some untransformed austenite. When steels are quenched in the normal way, the γ-α-iron transformation is not complete. Thus all carbon steels quenched in water in the ordinary way contain some austenite. The measurements carried out in order to determine the influence of annealing on the electrical resistivity and the specific volume of quenched carbon steels, have confirmed the fact that the martensite is transformed into troostite at 100 deg. to 200 deg. Cent., the reaction being most marked at about 110 deg. Cent. They also indicate that the austenite retained after quenching is decomposed at about 260 deg. Cent.

Colonel N. T. Belaiew referred to the papers on the same subject by Mr. Lucas and Dr. Desch, and said that Mr. Whiteley's work should be studied in association with them. Mr. Whiteley dealt with four types of martensite, and he gave an account of what he regarded as structureless martensite.

Professor F. C. Thompson disagreed with the idea that martensite was a solid solution. It was, as Colonel Belaiew had said, difficult to discuss Mr. Whiteley's paper by itself, but it must be read in conjunction with the work of Lucas. He found it difficult to believe that martensite was converted into troostite at a temperature of 900 deg., and any dogmatic conclusion on the change into troostite was justified by the known facts.

Professor Hoyt said that the X-ray evidence on the subject was rather disappointing. There was thermal evidence of a critical point in pure iron at about 600 deg. Cent. on quenching. He had found microscopic evidence that martensite in an ordinary piece of quenched steel was a two-phase material—a solid solution of iron with carbon, and a solid solution or compound containing carbon. Above that temperature the material was martensite plus austenite. The existence of two phases was clearly indicated. Martensite was confined to the low carbon and austenite was a component of high-carbon steels.

Professor E. D. Campbell expressed the opinion that the difficulties with which the subject was surrounded could not be entirely overcome by a study of the micro-structure of the material. The problem must be attacked by experts in X-ray work, and also by those who were working on lines connected with the magnetic and electrical properties of the material. It had been shown in the case of some nickel and nickel-chromium steels that the material was harder when quenched in oil than when quenched in water, and that there were abnormal magnetic and electrical properties.

Mr. Allemond said that the papers by Mr. Whiteley and that by Mr. Enlund represented valuable additions to knowledge of the micro-structure of quenched steels. He was not, however, able to accept the interpretation of the facts put forward by Mr. Whiteley.

This terminated the programme, the remaining papers being taken as read.

Sir Robert Hadfield, in moving a vote of thanks to the President, said the meeting was being held at a time of great depression in the industry. There was, however, no desire for State-aid, but it would be an advantage if the Government would display an intelligent interest in metallurgical affairs.

The President, in acknowledging the vote, said that whatever might be the rivalries in the commercial field, there were no international boundaries or division of interests on the scientific side. He welcomed the presence at that meeting of continental and American delegates.

SIXTY YEARS AGO.

In our issue of May 19th, 1865, a letter was reprinted which the well-known engineer Mr. W. Bridges Adams had sent to the *Society of Arts Journal*, regarding the construction of boilers. Mr. Adams held that the general structure of boilers was "radically vicious," and that it would continue so as long as the principle of riveting remained in use. It had been clearly established, he held, that the metal of a boiler should be all of one equal thickness, at least where it was in contact with the fire. If the metal were too thick it would, he wrote, simply burn away until it was reduced to the right thickness. It was impossible, he proceeded, to secure uniform thickness in the heating surface "until we got rid of the folded surfaces essential to riveting." To effect the change, he suggested that all the seams of boilers should be welded. The oxy-acetylene or other blow pipe or the electrical methods of welding which we now use were unknown or untried in those days, and Mr. Adams consequently had to describe in some detail his proposed method of welding the seams, an undertaking which must have seemed to many engineers of the time a difficult or impossible one. His plan was to place the two edges to be welded, cleaned of scale, in close proximity and to surround them with a box of fireclay fitting close to all the parts except those to be united. Entrances and exits were to be formed in the box after the manner of the "gates" used by iron founders in their moulds. Carburetted hydrogen gas and air were to be forced under pressure through the box and ignited in the interior, and when the surfaces to be united had become "pasty or partially melted," hydraulic or other pressure was to be brought to bear on them for the purpose of uniting them in a homogeneous manner. He argued that as there would be no free oxygen present inside the fireclay box no trouble would arise at the welded surfaces by the formation of scale.

B.E.A.M.A. SCHOLARSHIPS.—The B.E.A.M.A. gives notice that applications for the educational scholarships, session 1925–6, should be received not later than June 1st, and applications for renewal of scholarship, not later than July 1st. Full particulars of the scholarships may be obtained by writing to the Secretary, the B.E.A.M.A., 36, Kingsway, London, W.C. 2.

THE BARKING POWER STATION OF THE COUNTY OF LONDON ELECTRIC SUPPLY CO.

MESSRS. MERZ AND McLELLAN, LONDON, ENGINEERS

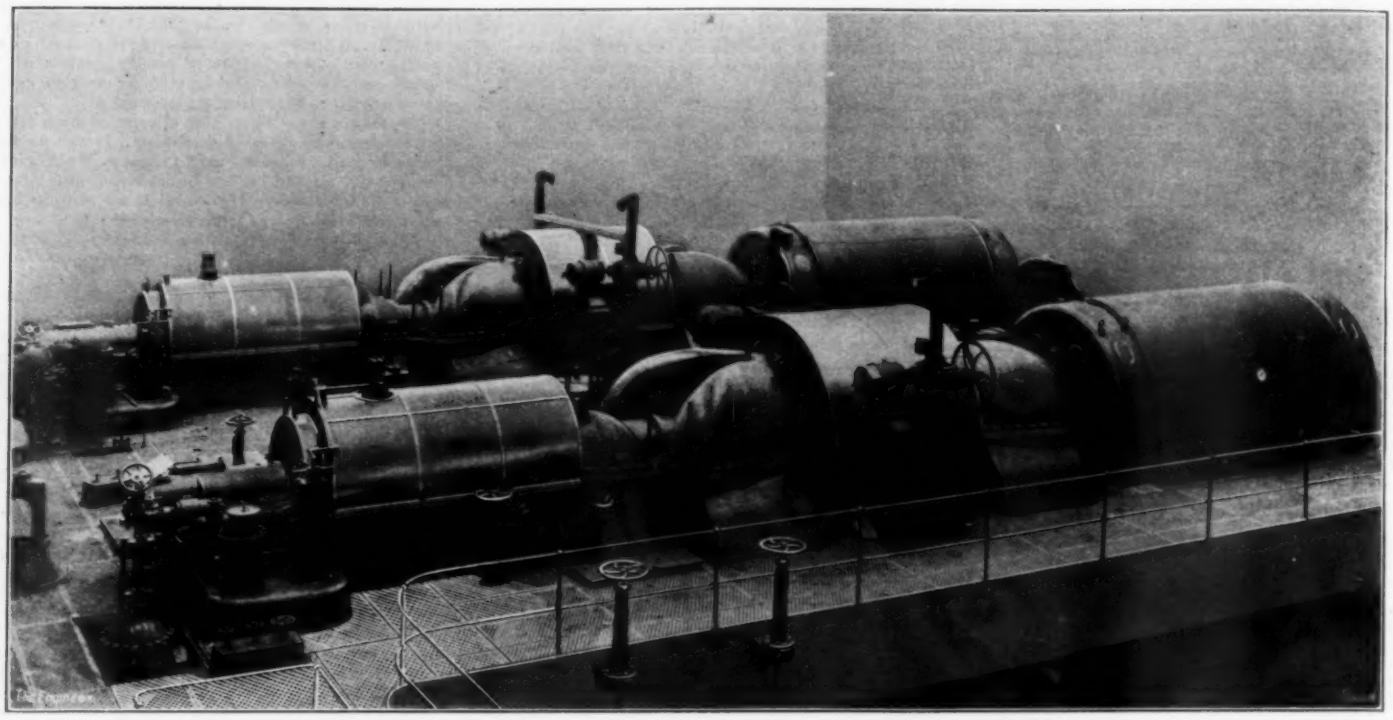


FIG. 1—40,000-KILOWATT PARSONS' TURBO-GENERATOR SET

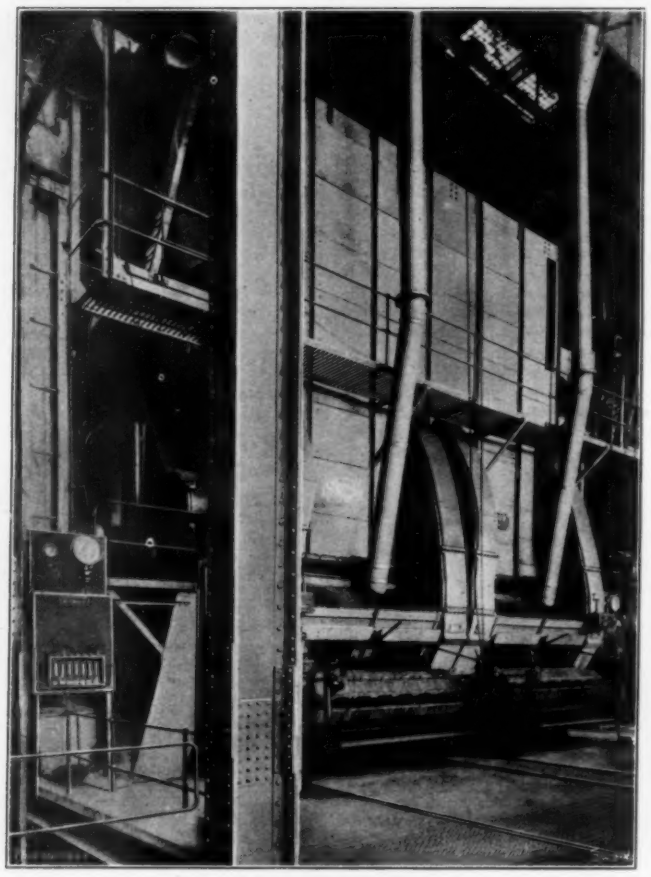


FIG. 2—YARROW BOILER

FIG. 3—BIRDSEYE VIEW OF THE STATION

FIG. 4—THE CONTROL ROOM

The Barking Power Station.

OPENED by the King on Tuesday of this week, the new Barking station of the County of London Electric Supply Company is now ready to contribute towards the long-promised cheap and abundant supply of electricity. It is equipped with the latest and best plant and apparatus which the engineering profession can provide, and it is to be hoped that in due course it will materially reduce the cost of current supplied to the consumer. The station contains nothing, however, that is unfamiliar to those versed in the most modern methods.

On obtaining the Romford and District Provisional Order in 1923 the County of London Company was empowered to supply over a wide industrial area in Essex on the north bank of the Thames, and this Order also authorised the erection of the Barking power-house with the object of supplying this area and the company's existing London and other areas. Under this Order the company was given perpetual powers for bulk supply, and also power to erect a generating station outside its area of supply—the first known instance of this kind under a Provisional Order. The first section of the station opened on Tuesday last is only a part of the programme in hand, which involves the installation of plant of over 250,000 horse-power, the capacity of the present station being about half that amount. The power generated in the immediate future will be transmitted to London and the other areas of the company's system by three-core, 33,000-volt cables buried for the most part direct in the ground. One group of these cables follows a route north of the Thames to a sub-station at City-road; another group crosses the Thames by a special tunnel and follows a route south of the river to Hill-street sub-station, Camberwell, whilst an interconnecting cable runs through the Rotherhithe Tunnel.

A view of the power-house as it stands to-day is given in Fig. 3, but the building will have to be extended before plant can be installed to the extent of 250,000 horse-power. The existing turbine room building, which is 300ft. long and 125ft. wide, contains four Parsons turbo-generator sets, two having a capacity of 40,000 kilowatts and two of 20,000 kilowatts, all designed for a speed of 3000 revolutions per minute. One of the 40,000-kilowatt sets is shown in Fig. 1, but it is a debatable point as to whether it could be called a single unit at all, for it will be per-

ceived that there are two tandem turbines and two alternators which work in parallel. Steam enters the high-pressure cylinder of one turbine and passes to the first cylinder of the other turbine and then flows through the two low-pressure cylinders. In the case of one of these 40,000-kilowatt sets a re-heater is inserted in circuit with the pipe which connects the two smallest cylinders in series, so that the steam is re-heated.

All the alternators generate three-phase current at a pressure of 6600 volts, and at a periodicity of 50 cycles per second, the pressure being transformed up to 33,000 volts for transmission. Below each turbine is a pair of condensers and the necessary condenser auxiliaries. On galleries below the main floor there are also evaporators for dealing with the make-up water and heaters for heating the condensate before it is returned to the boilers, steam being bled from the turbines in accordance with modern practice. All the condensing plant was supplied by Vickers Ltd., of Barrow. The main transformers, which raise the pressure from 6600 to 33,000 volts, are housed in a series of chambers arranged along the north side of the turbine room, and all the switching operations are carried out on the 33,000-volt side, in accordance with the practice adopted in certain other large stations, such as Dalmarnock and Barton.

The boiler house, which is at right angles to the turbine room, is designed to accommodate twelve water-tube boilers and four re-heaters to re-heat the steam between the cylinders in the manner described, but at present there are ten boilers which are arranged back to back. Five of these boilers were built and erected by Babcock and Wilcox, Ltd., and the remaining five by Yarrow and Co., Ltd., all the units being designed to operate at a pressure of 375 lb. per square inch, the steam being superheated to 700 deg. Fah. Each boiler is capable of evaporating 68,000 lb. of water per hour, the overload capacity of the Babcock boilers being 25 per cent. and that of the Yarrow boilers 50 per cent. Each boiler is fitted with two chain grate stokers, which are served from a line of overhead coal bunkers, in which in all about 3000 tons of coal can be stored. A view of one of the Yarrow boilers is given in Fig. 2. Air heaters have been installed to heat the air before it enters the furnaces, in accordance with the most up-to-date practice. Naturally, a very complete system of gauges for measuring temperature, draught, &c., has been installed, and a combustion engineer is to keep a watch over all the boiler house operations. At present, the company is not prepared to say anything about guaranteed steam consumptions, although it was rumoured, at the official opening, that the consumption for the 20,000-kilowatt generating units was 10.1 lb. per kilowatt-hour, and that for the 40,000-kilowatt set arranged for re-heating, something like 9.25 lb. per kilowatt hour. The actual thermal efficiency for the complete station, will we, understand be given in due course. The turbine room is spanned by two electrically operated cranes, one designed for a normal load of 90 tons and the other for a load of 18 tons.

In accordance with present-day practice in large power stations, the switches are operated from a control room, as shown in Fig. 4, situated at a distance from the turbine room so that the operators are free from disturbance. Moreover, in the event of abnormal happenings in the turbine room there is no chance of the switchgear being damaged.

Around the control room are grouped the administrative offices, whilst the main switch rooms are separated from the turbine room by a 20ft. roadway. For the sake of safety, the main ironclad Reyrolle switches are divided and placed in two separate buildings. Each switch is capable of breaking approximately 1,500,000 kilowatts, and they are, of course, all operated on the remote control system by means of push buttons on the panels in the control room, where the attendants can also regulate the speed of the turbo-alternators and operate the whole of the switchgear controlling the generators and the circuits which leave the powerhouse. In this room there is a large diagram of the company's distribution mains which enables the operator to visualise the whole of the system which the station is supplying, and the position of the switches in the main sub-stations. A complete set of telephones and telegraphs connects the switch room with the turbine room, and with other power stations and sub-stations on the system, so that the output of the Barking station may be regulated to secure the maximum efficiency.

The whole of the coal, which for the present section of the power house will amount to nearly 4000 tons per week, will be delivered direct to Barking from the coaling ports, the main jetty on the river front being 310ft. long, which will allow of steamers of 3000 tons burden being berthed alongside. On the jetty are two large cranes, each capable of grabbing coal from the vessel at the rate of 200 tons per hour. These cranes deposit the coal on a series of belt conveyors, so arranged that they can deliver either to the storage area or directly into the filler pits at the end of the boiler house, from which the coal is elevated by gravity bucket conveyors to the overhead bunkers. The first coal store, between the jetty and the boiler house, is capable of storing 28,000 tons. Across this store is a movable bridge of 200ft. span carrying conveyors, a jib crane, and grab. The second store, on the east side of the boiler house, has a capacity of 37,000 tons, so that there is a total storage capacity of about 70,000 tons. The whole store is served by a number of railway sidings.

Behind the jetty is a deep chamber containing six electrically driven centrifugal pumps which circulate the water through double ferro-concrete culverts from the river through the condensers, and back to the point of discharge. Self-cleaning revolving screens are fixed in front of the intake pipes to prevent weed and floating rubbish from being drawn in. At the end of the jetty is a small berth which later on will be used to accommodate barges into which the ashes will be dumped, to be carried out to sea.

The contracts for the power house were placed on exceptionally favourable terms, the result being that the capital cost per kilowatt installed is said to be below that of any other supply station of comparable size erected since the war. The whole of the plant and equipment is of British manufacture, and the total cost of the power and mains, &c., was about two and a half million pounds.

In addition to the Barking Station site, comprising about 100 acres, with an extensive river frontage, the County of London Electric Supply controls, through an associated company, a considerable amount of adjoining land, which it hopes to let for the erection of factories in need of cheap power. It is expected, in fact, to establish on this ground a second Trafford Park, and, if necessary, the company is prepared to assist manufacturers financially in connection with the erection of works. The principal contractors which took part in the construction of the Barking Station were as follows:—Babcock and Wilcox, Ltd., The Consolidated Construction Company, Ltd., C. A. Parsons and Co., Ltd., Metropolitan-Vickers Electrical Company, Ltd., Vickers, Ltd., A. Reyrolle and Co., Ltd., Yarrow and Co. (1922), Ltd., Christiani and Nielsen, The Cleveland Bridge and Engineering Co., Ltd., The British Insulated and Helsby Cables, Ltd., Callender's Cable and Construction Company, Ltd., W. T. Henley's Telegraph Works, Company, Ltd., Muirhead, Macdonald Wilson and Co., Ltd., John Mowlem and Co., Ltd., Fraser and Chalmers Engineering Works, W. H. Allen and Sons, Co., Ltd., The Enfield Cable Works, Ltd., Herbert Morris, Ltd., Stothert and Pitt, Ltd., Tredegars (1922), Ltd., John Wolstenholme and Sons, and Robert Dempster and Sons. The consulting engineers were Merz and McLellan.

A NEW ELECTRICITY COMMISSIONER.

It is announced that the post of Electricity Comsioner made vacant by the resignation of Mr. Archibald Page, who has become the manager of the County of London Electric Supply Company, has been offered to and accepted by Mr. S. L. Pearce, the chief engineer and general manager of the Manchester Corporation Electricity Department. Mr. Pearce joined the department twenty-four years ago, and became its head in 1904. Since that time he has had the satisfaction of seeing the undertaking grow to seven times its original magnitude. The Manchester supply area is particularly strong on its power side, and increasing demands resulted in the erection of the Barton super-power station, which was built to Mr. Pearce's design, and was opened in October, 1923. A description of the station was published in THE ENGINEER of October 12th of that year. Mr. Pearce was only recently appointed an honorary consultant engineer to the British Government. His new duties will necessitate his severance from Manchester, but Mr. Pearce's powers will find wider scope in connection with the furthering of the Government's plans for the development and cheapening of electricity supply throughout the country.

Obituary.

JOHN SAMPSON.

Widespread regret will be felt at the death of Mr. John Sampson, which occurred on the 11th inst. at Folkestone, as the result of an attack of septic pneumonia. Mr. Sampson was, perhaps, best known as a director of Thos. Firth and Sons, Ltd., of Sheffield, but he was, in addition, very intimately connected with many other important industrial undertakings.

John Sampson, who was the son of the late John Sampson, of Hayle, in Cornwall, was born in London in 1859. He was educated in a private school, and obtained his engineering training at the famous Thames-side works of Maudslay, Sons and Field, at which he remained for seven years or so, passing through the drawing-office and all the shops, and acting latterly as assistant engineer. Thereafter, for about eighteen months, he served at sea as a marine engineer in the fleet of Messrs. T. and J. Harrison. Having thus obtained sea-going experience, Mr. Sampson returned to the service of Messrs. Maudslays and was engaged largely with naval engineering matters, particularly in connection with the navies of Austria, Italy and Russia—occupation which took him frequently to the Continent for extended periods. His association with Maudslays continued during the remainder of that firm's existence, and in 1899, when the debenture holders procured the appointment of a receiver in their own interest, Mr. Sampson and Mr. Ernest Cooper, a chartered accountant, were nominated to act jointly as managers and receivers.

It was in the same year—1899—that Mr. Sampson was made a director of Messrs. Firths, a position he continued to hold with distinction till the time of his death. The sphere of action assigned to him at first was that of resident London representative on the board, and charge of the London office. He did not, at any time, we believe, during his long association with the firm, spend much time in Sheffield, but continued in charge in London, a position in which he gained a very large circle of friends in the shipbuilding, engineering and iron and steel trades. His was a nature which invited friendship, and as showing the affection with which he was universally regarded, it may not be unseemly to recall, in such a notice as this, that he was very widely known familiarly as "Uncle John."

Mr. Sampson's activities were by no means confined to his duties in connection with Messrs. Firths. Only five years after he became a director of that firm he was given a seat on the board of the now associated firm of John Brown and Co., Ltd. Later, he became a director of the Coventry Ordnance Works, Ltd., and of Dick, Kerr and Co., Ltd., and later still was actively concerned in the formation of the English Electric Company, Ltd., by the amalgamation of those two undertakings with others. He was also for many years closely connected with Harland and Wolff, Ltd., of which he became a director after the death of Lord Pirrie. He was also a director of the Power and Traction Finance Company, Ltd., and of the Projectile and Engineering Company, Ltd.

Mr. Sampson was a member of the Institution of Civil Engineers and of the Institute of Marine Engineers. During the war he visited Russia and the United States, being the British representative in New York on the Anglo-Russian Commission for Armament Supplies. He was also a member of the Financial Facilities Commission. For his war work he was made C.B.E. in 1918.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

A METHOD OF INCREASING WORKSHOP EFFICIENCY.

Sir,—In view of Mr. Baldwin's recent appeal for goodwill and co-operation between employers and employees, the contribution of Mr. F. J. S. Sharr to this subject in your issue of the 8th inst. should prove of particular interest to students of industry. The underlying principle of the scheme which he outlines is very well expressed in the sentence: "In effect, the greatest force in Nature, self-preservation, has been once more re-directed into the beneficial course of increasing output instead of being wasted in restricting output." In a word: The strong shall survive and the weak shall go to the wall.

Obviously, the basic principle of such a scheme is competition. Co-operation, in so far as it enters the scheme, is of a secondary nature, and is solely directed to a more efficient regulation of competition, so that by no chance do the strong, the meritorious, go to the wall.

The weak go to the wall with greater certainty and in increasing numbers. This is indicated by a reduction of 54½ per cent. in the weekly wages bill, corresponding to an increase of output of 31½ per cent. Obviously, since the men are paid a premium bonus on output, the number of men discharged must have greatly exceeded 54½ per cent.

Therefore, it is difficult to see that, in the aggregate, the men have in reality benefited by the promised increase of security; unless it be argued that, working under the former inefficient conditions, the shop would have been compelled to close down altogether. Furthermore, if at the incidence of this scheme the men had been warned that it would result in more than half their number being discharged, one wonders whether they would have shown the marked goodwill towards it, which Mr. Sharr relates.

Mr. Sharr does not show the increase in wages which the men received for the corresponding increase in individual output of 53 per cent. This would be very helpful in judging of the efficiency of the scheme from the point of view of the men who retained employment. On the employers' side, the evidence of its success is overwhelming. Indeed, one is inclined to regard it as a little one-sided. At the same time, it is questionable whether Mr. Sharr's method would operate so efficiently during a boom period, when labour is not so plentiful as it is at the present time.

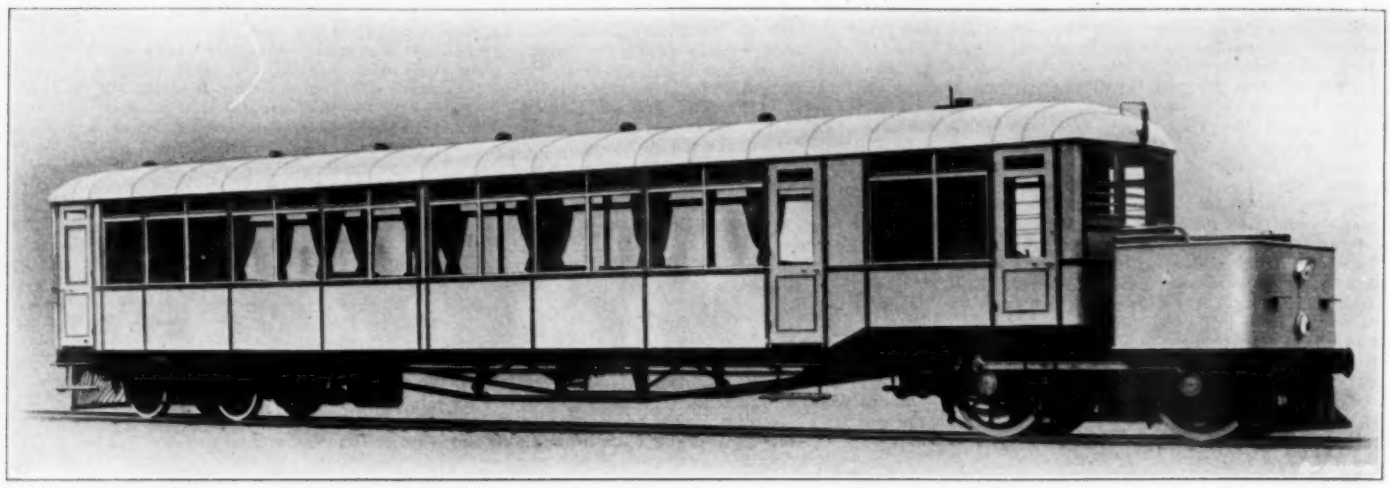
F. H. Towler.

Ilkley, May 18th.

According to the monthly report of the National Federation of Iron and Steel Manufacturers, the production of pig iron in April amounted to 569,800 tons, compared with 607,900 tons in March and 618,400 tons in April, 1924. The furnaces in blast at the end of the month numbered 158, a decrease of 11 since the beginning of the month, and a decrease of 36 compared with the number in blast at the end of April, 1924. The production includes 187,400 tons of hematite, 188,500 tons of basic, 138,200 tons of foundry, and 23,200 tons of forge pig iron. The production of steel ingots and castings amounted to 597,600 tons, compared with 684,700 tons in March and 711,500 tons in April, 1924. Imports of iron and steel in April amounted to 274,400 tons, the highest figure attained since May, 1924.

RAILWAY STEAM CAR FOR NEW ZEALAND

CLAYTON WAGONS, LIMITED, LINCOLN, ENGINEERS



The Effect of Camber on Wood-Paved Roads.*

By JAMES GARVIE, B.Sc., Assoc. M. Inst. C.E.

THE failure of wood-paved roads to stand up to modern heavy traffic is, in many cases, attributed to defective foundations, but the author considers that the degree of camber has a great influence on the life of these roads, particularly when expansion joints do not receive constant attention, the initial cause of the failures being due to the excessive curvature causing the blocks to rise from the foundation when they expand.

The paper does not deal with the subject of foundations as such, but only shows that they are often unduly strained.

Authorities are quoted to show that no method of treating the blocks is known by which the expansion can be materially reduced. An experiment showed that the maximum expansion in wood blocks as ordinarily used in this country was about 1.6 per cent.

The author classifies the failures in wood paving, apart from the foundation, as depressions, open joints, and blow-ups; but shows that all three can be traced to the blocks rising from the foundation when they expand. Under a depression the foundation may be in perfect condition, but, if left unattended, the pounding of heavy vehicles will damage the foundation, making this appear the cause of the failure, whereas the fault is in the elevation of the surrounding blocks. The open joints common in wet weather are due to the line of pressure between the blocks passing below the middle third when the blocks rise, the blow-up being the final result of this defect. The extensive damage often caused when water gets underneath a minor blow-up is put forward as being due to the hydraulic pressure generated by heavy vehicles, which forces the water under the surrounding blocks and raises them also. The action of ordinary surface water in disturbing the blocks by hydraulic pressure is not considered, as no proof that this takes place can be found; no blow-up having been found where there was room for expansion.

A definite figure as to the pressure exerted by the blocks, tangential to the road surface, cannot be given, but it is put forward as being in the neighbourhood of 2600 lb. per block of 5in. by 3in., and, considering the damage which is done at times by the expanding wood and for other reasons, this figure is taken to be fairly accurate. It is then shown that, if the blocks are to remain on the foundation when not given room to expand, the cross section of the road at any point should not be of greater curvature than the arc of a circle of 600ft. radius. Cambers universally used are shown to be very similar, and to give a radius less than 600ft. for roads up to a width of approximately 50ft., the majority up to a width of over 70ft. It is also pointed out that, as the height of the crown regulates the general curvature of the cross section, the methods adopted of setting out the cross section, otherwise than as an arc of a circle, can be neglected, for a flattening at one point can only result in a sharpening of the curvature at another.

Various reasons are given as to the unadvisability of providing expansion joints, which are often the cause of failures, and the author suggests that, except for very narrow roads, if the camber be that found by the formula $C = \frac{1}{80}\sqrt{(W^2 - 400)} - 1$in. (where C denotes the camber and W the width of the road), and if the cross section be an arc of a circle, an expansion joint need not be provided, and many causes of failure will be eliminated.

It is pointed out, however, that if this cross section is adopted, and the expansion joint omitted, some form of special construction will have to be put in to withstand the side thrust and so protect the curbs and footways and other adjoining property.

Railway Steam Car for New Zealand.

THE railway steam car, which is illustrated in the accompanying engravings, has recently been constructed by Clayton Wagons, Limited, of Lincoln—which, as our readers are aware, is associated with Clayton and Shuttleworth, Ltd., of the same city—to the order and specification of the New Zealand Government Railways, under the inspection of Messrs. Preece, Cardew and Rider, of London.

The "Clayton" railway steam car is specially intended to provide a means of handling passenger traffic on main lines during "non-rush" periods, and to act as an instrument for the exploitation of branch line services in districts where competition with road passenger transport on economical lines is called for. In the car illustrated, sitting accommodation for 57 persons is provided in the passenger compartment. An outside view of the vehicle is given above, and an interior view in Fig. 1. Fig. 2 shows the general arrangement, Fig. 3 is a drawing of the driving bogie, and Fig. 4 illustrates one of the roller bearings of the trailing bogie

FIG. 1—INTERIOR OF RAILWAY STEAM CAR

The body of the car is carried at each end on a swinging bolster. Each bolster is disposed midway between the axles of its respective bogie, and a double coil helical spring is fitted under the end of each bolster. The inclined swing links are short, and the side bearers are spaced widely apart. The headstocks are arranged for the reception of the New Zealand Government Railways' standard buffing and drawgear, and the centre pivot at the engine end of the car is designed to take buffing and traction stresses. The driving bogie wheel base is 7ft., the trailer bogie wheel base is 5ft. 6in., and the distance between bogie centres is 42ft. Curves of three chains radius can, the makers state, be negotiated with ease and safety. The overall length of the coach, which is for 3ft. 6in. gauge, is 55ft., the width 8ft. 2½in., and the height 11ft. 5¼in.

The underframe and body are of light weight construc-

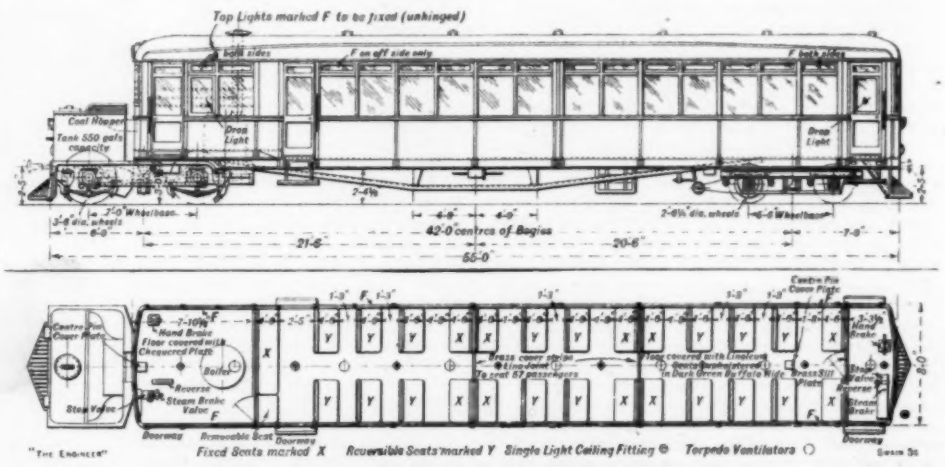


FIG. 2—GENERAL ARRANGEMENT OF RAILWAY STEAM CAR

tion. The longitudinal members of the underframe are rolled steel channels provided with fixed angle trusses, while the body and roof framing is of rolled steel sections, and the body pillars are carried by pressed steel brackets riveted to the underframe. The exterior body and roof panels are of charcoal-finished plates riveted to the fram-

* Abstract of a paper communicated to the Institution of Civil Engineers.

ing, and the body rivets are countersunk outside to present a flush exterior finish for the sides and ends of the body. Two cross partitions separate the front and the rear driving compartments from the passenger compartment.

The seats, which are sprung and padded, are upholstered in dark green buffalo hide. The floor of the passenger compartment is covered with Nairn's No. 1 dark brown linoleum, while the ceiling is white enamelled, and the body sides, doors and partitions are finished in dark polished mahogany. A luggage rack is fitted on each side of the passenger compartment above the windows, and runs the full length of the compartment. The top portion of each window is hinged to open outwards for ventilation and curtains are provided to all the windows. Torpedo ventilators are fitted in the roof with regulators on the ceiling. The car is equipped with Stone's system of electric lighting. The dynamo is driven by belt from one of the axles of the trailer bogie, and the accumulator box is carried in an angle iron sling underneath the underframe. A head lamp and a tail lamp are fitted at each end of the car. The brake rigging is of conventional railway pattern, and brake blocks are applied to all wheels. The brakes may be applied by steam or by a hand-operated screw. Sanding gear is provided on the driving bogie.

The power unit consists of the firm's standard engine and boiler as fitted in the "Clayton" undertype steam road wagon, but it is modified in detail for application to the railway steam car. The engine is mounted on bearings on the forward axle of the driving bogie, and is suspended by a link from one of the bogie cross bearers. A hardened steel pinion on the engine crank shaft drives a hardened steel spur wheel on the axle. The gears are totally enclosed and run in oil. The engine crank case is a steel casting, and the housings for the engine bearings on the axle are cast integral with it. These engine bearings are of bronze lined with white metal, and are pad lubricated from a well in each housing. The engine crank shaft is mounted on roller bearings and is balanced. The engine is of the two-cylinder high-pressure type, with all its parts totally enclosed. Distance pieces are provided to allow access to the cylinder glands and to prevent leakage of moisture into the crank case. Piston valves are used to control steam to each cylinder, and reversing is effected by a single excentric, enclosed in the crank case, which gives a large range of cut-off. The boiler is of the vertical water-tube type constructed to withstand a working pressure of 230 lb. per square inch, and tested to 400 lb. per square inch. The tubes, which are straight, are inclined upwards across the fire-box, and the whole of the latter can be unbolted and dropped out for examination at any time. An exhaust steam water heater is provided, and a coil superheater, which is arranged in the top of the boiler, gives a superheat of approximately 100 deg. Fah. The heating surface of the boiler is 51 square feet, and the fire-grate area 3.27 square feet. Each cylinder is 6½in. in diameter, and the piston stroke is 10in. With the engine running at 350 revolutions per minute the car speed is 35 miles per hour, and with 450 revolutions per minute it is 45 miles per hour.

The makers inform us that the boiler evaporates about 1200 lb. of water per hour, and that with coal of a calorific value of 14,000 B.Th.U., the fuel consumption is 4.8 lb. per mile. Under average conditions about 4 gallons of water are needed per train mile. The car has a water tank of 550 gallons capacity and a coal hopper of 15 cwt. capacity.

The axles of the driving bogie are coupled through side rods. The wheel centres, which are of the cast steel spoked type, and are balanced to compensate for the side rods, are pressed on to forged steel axles. The tires are of the New Zealand Government Railways' standard pattern to facilitate replacements from stock. The frame plates of the driving bogie are ⅝in. in thickness, and are provided with angle stiffeners. The hornblocks are of cast steel machined and squared. The driving boxes are of Stone's bronze with white metal inserts, and are syphon and pad lubricated. The water tank and coal bunker is mounted on the forward end of the driving bogie, and may be filled by the railways' standard locomotive watering and coaling appliances. A chute extends from the coal bunker into the driver's cab, and guard rails are fitted outside the end windows of the driver's cab. The boiler is mounted at the rear end of the driving bogie and is arranged so that the fire-box may be dropped for inspection without dismantling the brake rigging. A steam-driven boiler feed pump is provided in the driver's compartment, and a Holden and Brooke injector is fitted on the boiler. The complete driving bogie may be readily withdrawn from the car and an identical bogie fitted in its place.

The controls, including the regulator valve, the steam brake valve, the reversing lever and the steam whistle valve, are carried beneath the end window of the driver's cab, so that an unrestricted view of the track and signals is secured. The engine lubricator is fitted alongside the regulator and in full view of the driver. The sanding pedals and the hand brake column are arranged alongside these controls. All controls are duplicated at the rear end, so that the car may be driven with equal facility in either direction, thus dispensing with the necessity of turntables at termini. The floor of the driving compartment is of chequered mild steel plate, and this compartment is lined throughout with steel plates. A door is provided in each side and is fitted with a drop light. Two of the side windows and the end windows can be lowered.

The trailer bogie wheels have rolled steel disc centres, and the tires are of the New Zealand Government Railways' standard pattern so as to make renewals available from stock. The bogie frame is built up of standard rolled steel sections and the axle-boxes are of cast steel with Hyatt roller bearings.

The weight of the car unloaded is 20 tons 10 cwt., and when fully provisioned with water and coal its weight is about 23 tons 10 cwt.

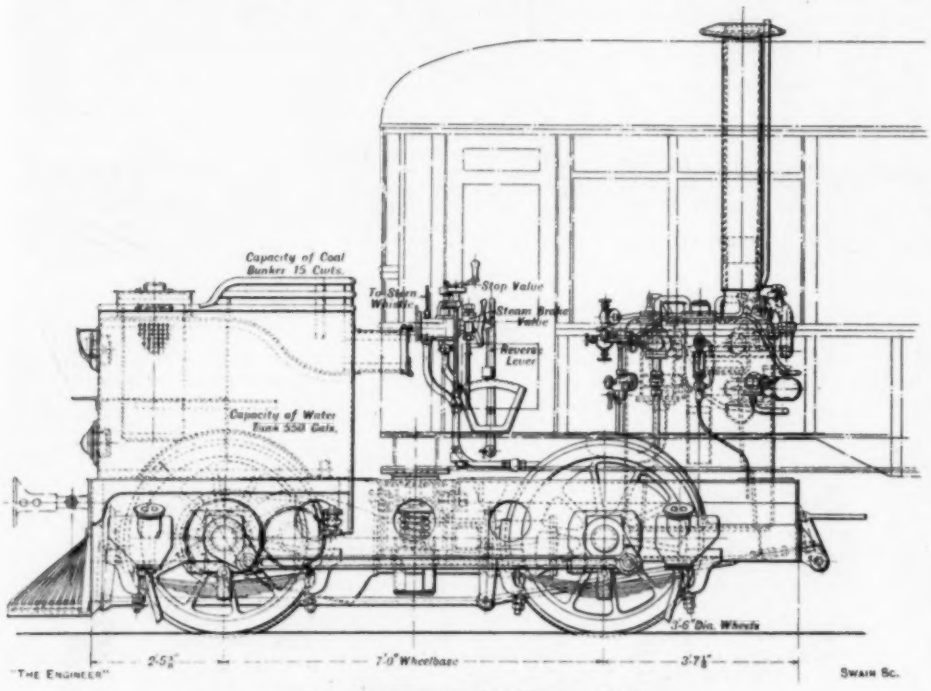


FIG. 3—ARRANGEMENT OF DRIVING BOGIE

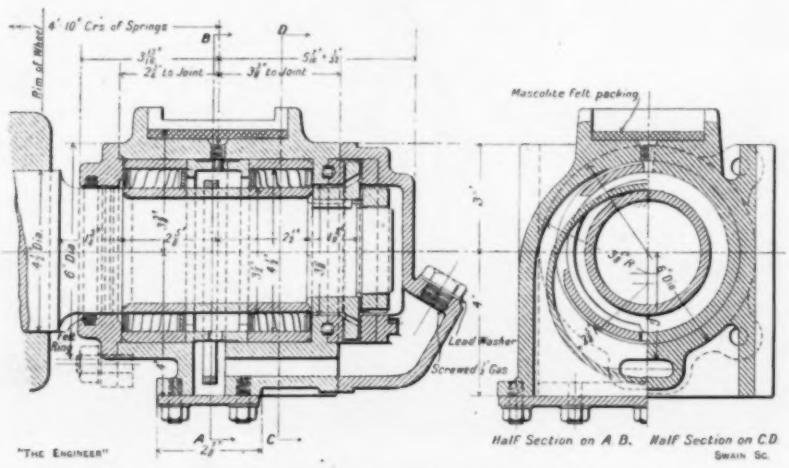


FIG. 4—ROLLER BEARINGS OF BOGIE AXLES

Modern Dock Equipment.

THE review of modern dock equipment which Mr. H. J. Deane contributed to the London Congress of the Institute of Transport raised a topic which has during a recent period become a subject of controversy. Following the criticisms of continental shipowners and the lack of adequate facilities at British docks, the Chamber of Shipping appointed a Committee to investigate the whole position. The report of this Committee was the subject of comment when it was issued last summer.

Mr. Deane's paper dealt with a good many of the points from the engineering standpoint, which were discussed in the report of the Port Facilities Committee. He discussed the relative merits of hydraulic and electric power as applied to dock equipment, and noted the general tendency in all new constructions to adopt electricity throughout. Referring to crane-handling plant, it was pointed out that although the modern quay crane was a very efficient tool, there were certain outstanding defects on which crane designers should concentrate their attention. The defects are mainly concerned with the revolving motion which is imparted to the mass of material in the jib and other parts of the superstructure. Comment was also made on the lack of progress in mechanical equipment for handling timber ex ship, and Mr. Deane drew attention to the tendency to employ a type of continuous transporter and conveyor. Dealing with the modern high-power floating derrick, Mr. Deane laid stress on the need of ample clearance, the provision of hoisting, luffing and slewing movements, two speeds of hoisting, so that small loads could be lifted at a high rate of speed, and the need that the propelling machinery, preferably twin screw, should be designed for speeds up to 5 knots.

Reference was also made in this contribution to the use of gravity runways, power-driven runways and conveyors, the electric battery truck for transporting goods between quayside and warehouse, portable piling and stacking machines, bulk grain-handling plant, and the discharge and loading of ore and coal. In connection with the shipment of export coal, the growing preference for the conveyor system was noted, and its advantages pointed out.

The general tone of the discussion suggested that the congestion at British ports, which has attracted so much attention, is not due, taking a broad view, to the lack of equipment, but to other causes.

Mr. Roger T. Smith referred to the efficiency of electrically operated handling plant. The installation at Fowey for the shipment of china clay by conveyor had brought out the great advantage this system possessed when the conveyor was placed at a right angle to the line of traffic.

Mr. A. G. Gardner (London and North-Eastern Railway) dealt with the question of the hydraulic hoist *versus* the conveyor for coal shipment. He showed that the engineer had not always a free hand. At one of the docks of the London and North-Eastern Company, the crane system had been installed by Lord Armstrong in the year 1851. The equipment had done, and was still capable of, excellent work, but was expensive to operate, and its removal, which was now in contemplation, was being made on that account alone. As to choice of plant, much depended on the conditions at the dock. At Immingham the hydraulic system was new; at Grimsby it was very old, the effect being that renewals at Grimsby would involve a change-over to the electric system, whereas at Immingham any extensions of the plant would be of the existing hydraulic type. On the subject of the relative merits of different types of grain-handling plant, the bucket and pneumatic conveyor systems, both had their advantages. At Immingham one of the largest bucket elevators which had been built was at work. The trouble with a good deal of handling plant, particularly coal-handling plant, was the interruption to loading caused by trimming operations, which made it impossible in practice to realise the designed speed of 600 tons an hour.

Other points which received attention were the need of improvements in timber-handling and general cargo plant. Dealing with the discharge of timber, Mr. du Platt Taylor insisted on the need of more efficient types of mechanical handling plant.

Sir Joseph Broadbent pointed out that the chief difficulty arose from the fact that timber imports formed a purely seasonal trade. If the quay accommodation at the Surrey Docks were doubled to provide for the peak of seasonal requirements, the timber importers would not be prepared to pay the price. One method of obviating congestion would be the better loading of timber cargoes, so that the difficult operation of sorting would be much diminished or done away with altogether. The position in London was complicated by the fact that timber was delivered in small consignments, and that in itself involved a great deal of work.

Mr. Deane reminded the meeting that the problem of handling timber had engaged and was still receiving close consideration, but the problem was very difficult.

Mr. Bryson Cunningham, dealing with the handling of general cargo, referred to an installation of the Scrutton plant at the Albert Docks. It was on the overhead runway system, the runways being carried on to the ship and being fitted with a detachable portion, which could be lowered into the gangway.

Mr. E. S. More said that the chief lesson impressed on

the Port Facilities Committee during their inspection of the British docks system was that it was not a question of equipment so much as a lack of co-operation between employers and employed.

Vulcan-Roadless Half-Track Vehicle.

WE reproduce on page 574 a series of photographs taken of what its builder, the Vulcan Motor and Engineering Company (1906), Ltd., of Southport, calls its Roadless half-track vehicle, during some trials which were carried out a few days ago on the sandhills at Birkdale in Lancashire.

The vehicle, which is designed to carry a useful load of 2 tons, and to haul one or more trailers on reasonable surfaces, with an additional load of from 4 to 5 tons, is fitted with a track which the Vulcan Company manufactures under licence from the Roadless Traction Company, Ltd. It can mount gradients up to 1 in 4. In newer models, so we understand, a quick-change attachment, which will enable the vehicles to be operated with ordinary road wheels, is to be fitted.

The engine has four cylinders, 95 mm. bore and 130 mm. stroke, and it is of 22.4 horse-power, R.A.C. rating. The crank shaft is hollow, and through it oil is forced by means of a gear pump to the journal and connecting-rod bearings. A double thrust washer is arranged at the front end of crank shaft to take the end thrust. The valves are on the near-side, and are operated by means of adjustable tappets, the valve gear being enclosed by an easily detached cover. The ignition is by high-tension British magneto, and the carburetter is of the Zenith pattern. Cooling is effected by a radiator of the gilled tube type, in combination with a fan and water pump circulation. The cone clutch, which is Ferodo faced, is fitted with adjustable springs, and there is a flexible-disc universal joint between it and the gear box. There are four forward speeds and reverse and a central gate change. The total ratios are as follows, the first speed having a specially low ratio :—

Top speed	10.3 to 1
Third speed	15.9 to 1
Second speed	26.3 to 1
First speed	69 to 1
Reverse	115 to 1

Transmission is by an open tubular propeller shaft fitted with a well-lubricated cross pin type of universal joint. The overhead worm and wheel—10.3 to 1 reduction and spur differential—transmit the drive through high-tensile steel shafts to the driving sprocket wheels, which run in removable bronze floating bushes. Drawn steel tubes are used to carry the spring seats and bogie brackets. Two four-wheel rubber-tired bogies run on the inside of the endless tracks, and are fixed to the bogie brackets by spherical joints to give universal motion. The forward end of the bogie frame carries an idler wheel on an adjustable arm, these wheels being fitted with rubber tires, to ensure quiet running of the endless track. The drive is transmitted from sprocket wheels on the driving axle to the endless tracks, which consist of stamped steel links having automatically lubricated spherical joints which are designed to permit cornering without drag on the road surface. A radius of 17ft can, we are assured, be easily taken. The frame is of deep channel section, in pressed nickel steel with cross members. A draw-bar attachment is provided. The springs, both front and rear, are of the semi-elliptic type.

There are two independent braking systems. A foot pedal operates large diameter contracting type shoes on drums mounted behind the gear-box, and a hand lever operates, through compensating gear, expanding shoes, 18in. in diameter, on the rear wheels. Steering is effected by worm and worm wheel which work in oil, and control is by foot accelerator pedal and also hand throttle and ignition levers on the steering wheel. The front axle is a heavy I section of 40-ton steel, forged in one piece.

The petrol tank, which is carried on the dash, gives gravity feed to the carburetter, and has a capacity of 22 gallons. The front wheels, which are of the steel disc type, are made to take 34in. by 7in. straight-side pneumatic tires. The following are the leading particulars of the vehicle :—

Wheels base	9ft 7½in.
Track	4ft. 11½in.
Length overall	19ft. 2½in.
Width overall	6ft. 5½in.
Loading platform	10ft. 8in.
Chassis weight, unladen	F.A. 17 cwt., R.A. 44½ cwt.

Radium from a Cornish Mine.

AN interesting paper on the production of radium at the South Terras mine was given by Mr. Maurice Gregory, A.I.M.M., of Redruth, at a meeting of the Cornish Institute of Engineers on Saturday, April 25th. The lecturer said that radium had been produced in Cornwall at two mines only, Wheal Trenwith, St. Ives, and South Terras, St. Stephens, though radium ores were reported from at least twenty-one different mines in the county. Radium he described as a product of the transmutation of metals, a natural process in this case, but one which the alchemists of the Middle Ages had tried to accomplish artificially, principally with a view to transmuting lead into gold. Radium had upset to some extent the preconceived atomic ideas. All the elements were probably breaking down and emitting an emanation or forming themselves into something else; but science had not yet devised instruments sufficiently sensitive to detect it, except in the case of uranium and a few others, the former having an atomic weight higher than any of the other elements.

South Terras mine was accidentally discovered when quarrying operations for building stone in an elvan were in progress. A green streak or narrow vein of green ore was cut, which on analysis proved to be torberite, a phosphate of uranium and locally known as "Green Jim." When the deposit was further opened up a valuable and extensive lode was found to exist, and systematic mining operations were then carried out. As the Continent offered a good market for uranium, the "Green Jim" was packed in barrels and sent to Germany for the manufacture of yellow uranium glass. This ore of uranium contained the radium, the discovery of which was not made until twenty years after the mine was opened, and over 1000 tons of uranium ore having an unsuspected radium value of £450,000 was sold from this mine before the discovery of radium. Since its discovery and up to 1914 the mines produced and sold ores having a radium content to the value of over £3,000,000. After the war a reduction plant was erected at South Terras, and Mr. Gregory said that for two and a-half years his duty had been to deliver ore in a state suitable for chemical treatment in order to extract radium from it. It was now produced on the spot in the form of radium barium chloride, in which state it was sent to France to be finally concentrated.

Mr. Gregory expressed the opinion that radium was more widely distributed than was generally known, and that there was a great deal more of it in Cornwall than the outside world ever suspected or gave the county credit for. Air from deep borings in the earth was found to be radio-active. Hot springs and many mine waters in certain parts of Cornwall were also radio-active, and before the war water from an old mine shaft near Ponsanooth was regularly sold for its radio-active properties. Radium had peculiar electrical properties by which it was possible to measure its activity and determine its value. Its rays would penetrate anything except lead, and even that must be very thick to withstand the powerful bombardment of this atom. When heated to boiling point it lost its properties, which returned, rapidly at first, and tapering off until a period of about thirty days had elapsed, when full strength was again attained.

Foundry Sand Recovery Plant.

THE plant shown in the engraving below has recently been supplied by the New Conveyor Company, of Smethwick, to a foundry in Japan for treating used foundry sand, in order to make it serviceable again, by removing any iron or hard lumps which it may contain.

The plant, it will be seen, comprises an elevator and the necessary separating and screening gear, all mounted on a steel framework above the floor level, so that it may be put to work in any convenient position. The boot of the elevator, which is protected by a grid to prevent large masses of rubbish from damaging the buckets, is only 3ft. above the foundation level, so that it is an easy matter to shovel the sand into it. The sand is delivered by this elevator to a height of about 9ft., and slides down a shoot on to a magnetic separator, which removes any particles of iron.

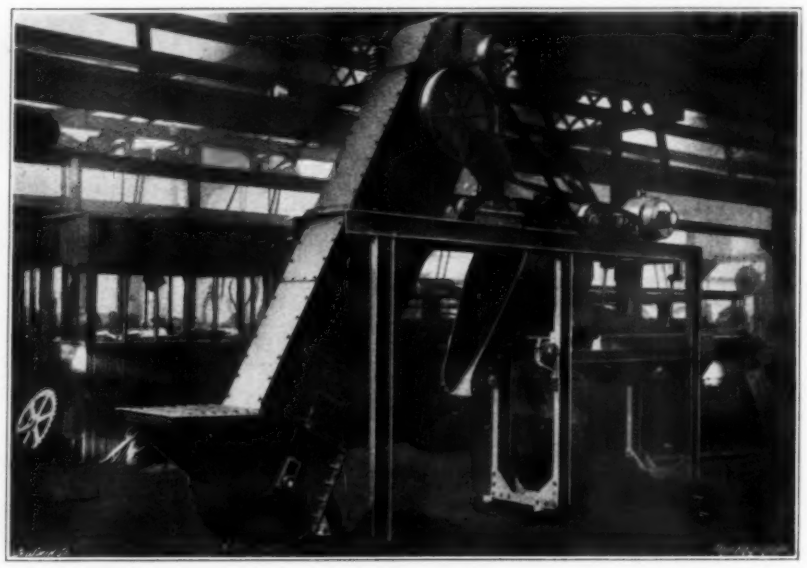
This separator, by the Rapid Magnetting Company, of Birmingham, is of the band type. That is to say, the material is sorted as it is carried by a band running over two drums or pulleys, one of which is furnished with powerful magnetising coils. The two drums have ball bearings and are driven at such a speed that the band travels at about 130ft. a minute. One of the drums is an idler and is mounted on sliding pedestals so that the stretch of the band can be taken up. The other drum is built up of alternate sections, or discs, of magnetic and non-magnetic iron, between which there are arranged the magnetising windings. The two ends of the windings are carried out through the shaft to a pair of slip rings, which are totally enclosed by a substantial casing, but are readily accessible. These windings produce a very intense magnetic field all round the drum, which is accentuated locally by iron studs, or projections, riveted to the band. The result is that any iron which may be in the sand is attracted to these studs as soon as it comes within the influence of the field, and is held there until the band has passed the drum again. At this point there is the shoot, plainly shown in the illustration, and the iron drops off, down this shoot, into any convenient receptacle.

The sand is not, of course, influenced by the magnets and runs off the end of the band into a separate shoot, which leads it into a jigging screen. The screen is of ¼in. mesh expanded metal, and is reciprocated at about 150 double strokes a minute by an excentric gear. The fines, which drop through this screen into the hopper between the back legs of the plant, provide the usable sand, while the oversize, which may be odd bits of wood, brick and so forth, are shot over the end into a separate heap.

The whole of the moving parts are driven by a 4 horse-power electric motor, which can be seen mounted on the top of the framing. This motor runs at a speed of 1390 revolutions per minute, and drives the main shaft, at a speed of 325 revolutions per minute, through an enclosed chain gear. The elevator, separator and screen are connected with this shaft by means of belting.

The electricity supply to the coils of the separator must, of course, be continuous current, as the apparatus would heat up too much if alternating current were used, and is controlled by a special controller, very similar to that used for tramcar motors. By switching on the current the coils are put in parallel, step by step, with a set of four resistances, which are in series, until the four resistances and the magnet coils are in parallel across the mains. The last step is, however, effected by an automatic quick acting trigger, which connects the coils across the mains only momentarily, and then reverts to the previous step, which leaves one of the resistances in series with the combination. The object of this arrangement is to increase the current momentarily so as to get the highest possible flux density in the magnet and to reduce the current again, by the resistance, to a more reasonable amount. The flux does not, nevertheless, fall off again naturally on account of the "retentivity" of the iron of the magnets. The final step of the controller cuts out the resistances in parallel with the magnet coils, in order to economise the current, which would otherwise be shunted through that path.

The plant illustrated is capable of handling from 3 tons to 6 tons of sand an hour.



FOUNDRY SAND RECOVERY PLANT

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.

The fifty-second annual general meeting and conference of the Institution of Municipal and County Engineers will be held in Harrogate on June 17th, 18th, 19th and 20th, 1925.

The following programme has been arranged :—On the Wednesday, June 17th, 1925, at 10 a.m., members will assemble in the Royal Hall, for the transaction of business. At 11.30 a.m., visitors and delegates will be admitted, and a welcome extended to the Conference by the Mayor of Harrogate, Mr. Frank Massie, M. Inst. C.E., F.S.I., will then be installed as president, and will deliver an address. The award of Richard Pickering Prize and Medal for the year 1924–25, will then be made, and the subject of the thesis for the Richard Pickering Medal and Prize for the year 1925–26, as well as the Award of Premiums announced. The Scorgie and Carter Challenge Shield will also be presented. In the afternoon at 2.30, in the Royal Spa Concert-room, Sir Henry P. Maybury, K.C.M.G., Director-General, Roads Department, Ministry of Transport, will deliver an address, after which the following papers will be discussed :—(1) "Harrogate and its Municipal Undertakings," by C. E. Rivers, A.M. Inst. C.E.; and (2) "Assistance from National Funds for Sewerage Works and Water Supply in Rural Districts," by A. J. Redfern. In the evening, at 8.15 p.m., there will be a reception by the Mayor and Mayoress of Harrogate in the Winter Gardens.

Thursday, June 18th, will be devoted to a visit to Harrogate Reservoir and Fountains Abbey, the annual dinner of the Institution taking place in the evening at the Hotel Majestic, at 7 p.m. On the Friday there will be a meeting in the Royal Spa Concert-room, at 10.30 a.m., when Mr. G. L. Pepler will deliver an address on "Town Planning for Rural or small Urban Districts," and a paper on "Sewage Works for Smaller Districts," by J. D. Watson. M. Inst. C.E., will be discussed. At 1 p.m. a visit will be paid to the Royal Baths. At 2.30 p.m., in Royal Spa Concert-room, the following papers will be discussed :—"The Smaller Boroughs : Their National and Economical Administration Value," by J. W. Hipwood, A.M. Inst. C.E.; and "Municipal Undertakings in Small Boroughs," by Gilbert A. Ballard, A.M. Inst. C.E. At 4 p.m. there will be a visit to the Harrogate Central Depôt, and at 7 p.m. a Ladies' Festival of the Municipal and County Engineers' Lodge, No. 3920, at the Hotel Majestic. On the Saturday the Harrogate Southern Outfall and Sewage Disposal Works and Knaresborough will be visited.

Railway Matters.

THE Great Western new line between Oxley and Kingswinsford, referred to in our annual article on Railways on January 9th last, was opened on the 11th inst.

CONSIDERABLE constructional alterations were effected at the Victoria and Exchange stations, Manchester, on Sunday last, May 17th, with a view to their becoming one common station.

THE whole of the alterations at the Bank Station of the Central London and City (and South London) Railways have now been completed. They include an escalator tunnel, 27ft. in diameter, driven at an angle of 60 deg. under the roadway, amid a maze of water, gas and electric service mains. Five electrically operated lifts have been dispensed with, and the new escalator handles 30,000 passengers daily.

THE Londonderry and Lough Swilly Railway has been passing through a time of such financial strain that, if rumour may be accepted, it will have to be closed down. The property lies mainly in the Irish Free State, but its Londonderry Station—and therefore its most important traffic—is in the Northern Territory. Both Governments have been asked for assistance; the Free State has made an offer, but not of sufficient amount, and now it is hoped that the Northern Government will provide the remainder necessary.

FOR two years the Southern Railway Company has been strengthening and rebuilding bridges on the two main South-Eastern continental boat train routes, and this summer for the first time ten engines of the "King Arthur" class will be used on these routes. The rest of the class will be put into service on the South-Western section, an arrangement which will allow of a corresponding number of smaller but efficient express passenger engines being transferred from this section to the Kent coast and South-Eastern section.

PROGRESS in the discussion of the National Union of Railwaymen's "all-grades" programme was suspended because the railway companies pointed out that the union had no authority to speak on behalf of the shopmen. It was suggested that the N.U.R. should get this authority, and a synopsis of the correspondence that resulted has recently been issued. It shows that five unions would not, for various reasons, discuss the matter, and only the Workers' Union agreed to do so. As the labour correspondent of the *Manchester Guardian* observes, "the correspondence shows very plainly how strong is the antipathy between the crafts unions and the N.U.R."

THE Khyber Railway, now being constructed by the North-Western Railway of India, runs from Jamoud to Landikhana, a distance of 27.74 miles, and is of 5ft. 6in. gauge. For the present only 26.35 miles will be completed. The reduced level at Jamoud is 1496, at Landi Kotal, the summit, it is 3495, and at Landi Khana it is 2622. There are altogether thirty-two tunnels of the total length of 2.55 miles, but none exceed 1400ft. in length. The line is built to the new Indian standard structure gauge of 16ft. high and 12ft. wide, instead of 13ft. 6in. and 10ft. respectively, and the bridges provide for the new maximum loading of 24 tons per axle. The contractors are influential Afghan tribesmen, and as they have had no experience of such heavy work, all skilled labour has had to be imported. As *The Times* Simla correspondent cables that the line will be completed by the end of October or the beginning of November, and the opening ceremony will be presided over by Lord Reading, we have extracted the foregoing information from the last annual report of the Indian Railway Board.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first three months of the present year was as follows, the corresponding figures for 1924 and 1923 being added in brackets:—Locomotives, £883,056 (£583,917, £839,744); rails, £483,715 (£538,519, £470,120); carriages, £459,416 (£306,194, £328,356); wagons, £835,310 (£952,912, £829,725); wheels and axles, £172,661 (£200,610, £243,353); tires and axles, £120,523 (£183,171, £104,191); chairs and metal sleepers, £148,759 (£353,650, £156,747); miscellaneous permanent way, £362,112 (£354,605, £265,882); total permanent way, £1,318,898 (£1,693,737, £1,311,781). The weight of the rails exported was 50,095 tons (60,530 tons, 54,996 tons), and of the chairs and metal sleepers 11,729 tons (27,009 tons, 13,817 tons). During the month of March last locomotives of the values named were shipped to the following countries:—India, £231,577; the Argentine and other countries in South America, £13,035; South Africa, £10,556; and rails as follows:—The Argentine, £25,265; Australia, £13,963; India, £12,860; New Zealand, £9679; Ceylon, £4827; South Africa, £4389; and British West Africa, £4162.

TO-DAY is the tenth anniversary of the most serious disaster that has occurred on British railways—that at Quintinshill, Caledonian Railway, on May 22nd, 1915. One of the remarkable features of that accident was the many small things which might have prevented it. Had the express from Euston been nearer its proper time, the local train would have followed it from Carlisle, and not have had to be shunted for it to pass; had the down loop not been occupied with some wagons, the local would have used the loop and not have been shunted on to the up main line; had not an up goods train been approaching at the time the local was shunted across, the signalman would have blocked back for the local, but he could not do so, because the block instrument was recording the goods train; as most of the deaths arose from the down express running down the escaping soldiers and ploughing its way into the wreckage of the first train, the passage of that train two minutes earlier would have considerably reduced the effects of the first collision. The destruction by fire was so great that it was not known exactly how many lives were lost; 165 bodies were recovered, and a subsequent roll call showed three officers and forty-seven other ranks to be missing. Some of the latter afterwards turned up in Gallipoli, having travelled by other trains. The men belonged to the Royal Scots, and a statue to their memory was erected in Edinburgh and unveiled the following year by Lord Rosebery.

Notes and Memoranda.

IT is reported that a platinum reef of great width has been discovered in the northern portion of the Lydenburg fields near the Olifants River, North-Eastern Transvaal. The reef has been traced for 9 or 10 miles and in one place, where fully exposed, it is 70ft. wide. The surface values are two to three pennyweights per ton.

BY heating powdered coal to high temperatures and pressures in an atmosphere of hydrogen, liquid fuel can be obtained. Up to the present several different types of English coals have been investigated, and Professor Nash, of Birmingham University, states the results are encouraging. A South Staffordshire coal, on hydrogenation, gave 37 per cent. of liquid, a South Wales coal 26 per cent., and a Lancashire coal 61 per cent. These figures give respectively 80, 56 and 130 gallons of liquid per ton of dry ashless coal.

SPEAKING recently at Sydney, when the foundation stone of the Sydney Harbour Bridge was laid, Sir Hugh Bell mentioned, as an instance of the meticulous care exercised in the construction of the bridge, that his firm had constructed a tool for the testing of the cableways that would hold up the weight of the cantilever portion of the bridge, pending the insertion of the arch. The tool had cost £16,000, and was the only tool of its kind in the world. When the arch section of the bridge was fitted into the cantilever section, all that would be necessary to bind the two together would be an 8in. pin 10ft. 6in. long.

THE erection of the temporary bridge at Waterloo by Sir William Arrol and Co., Ltd., is not without its thrills. It would seem, indeed, to have a romantic spice of danger other than that connected with pure engineering. A short time ago workmen engaged upon the foundations of one of the new columns retrieved from the mud of the river bed an unexploded German bomb. Comparatively small in size, it must have been dropped from an aeroplane during one of the numerous raids on the Metropolis, almost simultaneously perhaps with one of the bombs which damaged Cleopatra's Needle near by. A matter of 20ft. further westward and the long controversy as to whether or not Waterloo Bridge should be rebuilt would, says the *Glasgow Herald*, have been dramatically solved before the war ended.

DURING the recent French aerial expedition to Gao two of the machines were equipped with an apparatus called a Navigraph by the inventor, Chief Engineer Laubeuf. Three stages of the journey were, it is said, made solely with the Navigraph. The first 1200 miles was over the Mediterranean from Alcazaros to Oran, where the machines landed only a mile and a-half from the desired place. The second, 200 miles, was over the Sahara, without a single landmark to guide the pilots. In this case the error was only half a mile. The third stage, also over the Sahara, from Tessalit to the Niger, was completed with an error of only two and a-half miles, with a wind blowing at the rate of 25 miles an hour. Had the aeroplanes been steered solely by compass the deviation might, it is said, have amounted in some cases to 40 miles.

WHEN oil is used as a fuel it should be deprived as far as possible of the traces of water with which it is usually adulterated. The presence of water not only reduces the heating value, but interferes with the conditions necessary for perfect combustion, and is liable to produce special troubles with boilers of the marine type. The lowering of the temperature, for instance, prolongs the length of the flames, thus carrying the point of highest temperature further forward and tending to increase the temperature in the combustion chamber to a point which may give trouble, while it causes the last stage of combustion to take place in the smoke box and funnel, where the heat is wasted. When the oil spray is satisfactory and combustion perfect the flame is opaque and dazzling white for a distance of some 6in. from the nozzle, becoming violet at the middle of its length and shading into red at the end. If water is mixed with the oil the violet colour never appears and the end of the flame becomes dark red and smoky.

FURTHER information regarding the recent discovery of coal at Kamasamudram, a village about 18 miles from Bowringpet, in Mysore, mentioned in the *Iron and Coal Trades Review*, shows that the coal is of excellent quality, and that the deposits are spread over a very large area which may extend to about 100 square miles. Mr. Schomberg, the Mysore expert, who made the discovery, has now sunk a bore down to a depth of 250ft., and intends carrying it down to 500ft. At the request of the Mysore Government the Ooregum Gold Mining Company has commenced sinking a trial shaft. The ground, so far, has been of a very loose and soft character, and water has already been found, so that it will be necessary to start pumping very soon. Facilities for the development of the deposits are plentiful. Skilled labour can be imported from the gold mines, while there is abundant unskilled labour locally. Kamasamudram can be easily connected with the south of the Kolar goldfield by an electric railway or tramway. The shales already found have been subjected to analysis at the Indian Institute of Science, Bangalore, and the results show a high percentage of carbon.

TWO new aluminium alloys, placed on the market by the Aluminium Company of America, were recently described in a paper read before the American Institute of Mining and Metallurgical Engineers in New York. The first is an aluminium-copper alloy which shows substantially no hardness increase on ageing at ordinary temperatures after quenching from around 500 deg. Cent., but is susceptible to marked hardening by re-heating at 100 deg. to 175 deg.; while the second is an aluminium-magnesium-silicon alloy, which hardens to some extent on ageing at ordinary temperatures, but can be improved by artificial ageing. The alloys are available in the form of sheet, bar, rod and wire, tubing and shapes, both rolled and extruded. They are ordinarily used in the heat-treated condition and when properly heat-treated the first has a tensile strength of 30,000 lb. to 45,000 lb. per square inch with an elongation of 10 to 3 per cent. in 2in., while the second alloy will have a tensile strength of 17,000 lb. to 30,000 lb. per square inch with an elongation of 15 to 5 per cent. They have been introduced in order to overcome some of the difficulties experienced in the fabrication of duralumin.

Miscellanea.

THE first new shipbuilding order placed on the Tees this year has been secured by Smith's Dock Company, which has received orders for the construction of three medium-size cargo vessels for British owners.

THE bridge which is to connect Montreal with the South Shore will be 3750ft. long. It is to have nine spans of 250ft., two of 200ft., four of 150ft., and three of 125ft. The estimated cost of the bridge is 8,000,000 dollars.

THE entire German tube trade has, we learn, formed a syndicate for seven years in order to protect its interests, and in particular to restrict to the utmost the import of foreign material in view of the over-production of the German tube works.

THE eleventh German destroyer S. 65 was successfully raised from Scapa Flow by Cox and Danks, Ltd., of London, on Saturday, the 16th inst. Floating docks were moored over the wreck on the afternoon of May 12th, and the destroyer was lifted in the record time of four days. The previous destroyer was raised on May 1st.

PRACTICAL experiments in the removal of dust from potters' shops are being carried out at different factories by the Pottery Industry Research Committee with various types of vacuum suction cleaners, the contention being that with such cleaners the dust is speedily removed with the added advantage that no dust arises in the air to re-settle on ware, benches, beams, &c.

WE hear that Low Temperature Carbonisation, Ltd., is to erect on the land of the Digby Colliery Company, near Nottingham, a plant capable of carbonising 1000 tons of coal per day, and to supply over a long period of years an improved standard quality gas to the Corporation of the City of Nottingham, as well as producing large quantities of smokeless fuel of the Coalite type.

THE Brighton Sewers Board has decided to apply for a loan of £90,000 for the reconstruction scheme of the sewer outfall at Portobello. The present outfall will be extended to a point 100 yards further seawards and will be well submerged to discharge below low-water mark. The sea wall which is to be constructed from the line of the sewer to the boundary of the Board's land will be of mass concrete which will not be reinforced.

AT the thirteenth annual general meeting of the British Engineers' Association, held at the Hotal Victoria, on May 14th, Mr. H. J. Ward, of J. and E. Hall, Ltd., Dartford, was unanimously elected president in place of Sir Ernest W. Petter, who retired after holding office for two years. Messrs. Harry Allcock, Colonel P. B. Crowe, F. H. Livens, and Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D., were elected vice-presidents, and the following were elected members of the Council, W. G. Ardley, H. M. Butler, R. A. Blakeborough, Chas. H. Booth, C. E. Douglas, F. C. Fairholme, David Lycett Green, Arnold Gamble, Sir James Kemnal, J. F. Parker, Philip D. Priestman, Gerald F. Prest, R. S. Rowell, Sir John Thornycroft, K.B.E., Gilbert C. Vyle.

IN our issue of February 20th last we drew attention to a coke competition which had been organised by the *Gas Journal* through the generosity of the Woodall Duckham Companies, which had contributed £1000 for distribution as prizes. The object of the competition is to endeavour to pool from all parts of the world experiences and the results of research with the view of—if economically possible—improving gas coke qualitatively, and preparing it in the best condition for the purposes to which it is applied. We are now asked to announce to prospective competitors that the latest date for the reception of the papers will be June 30th. Further particulars may be obtained from Mr. Arthur F. Bezant, the *Gas Journal*, 11, Bolt-court, Fleet-street, London, E.C. 4.

THE Department of Overseas Trade is informed that under the auspices of the Government of the United States, a permanent International Trade Exhibition will be opened at New Orleans, Louisiana, on September 15th. The Exhibition is for the purpose of permanently displaying samples of manufactured and raw products of the United States and all other countries participating in the Exhibition, and the President of the United States has, consequently, formally invited all foreign countries to take part. The Exhibition is designed to include all branches of industry, among those of special interest to engineers being motor vehicles, building and sanitation, machinery, wireless equipment, electrical appliances, agricultural implements, vehicles, boats, &c. A copy of the pamphlet containing further information may be consulted at the Department of Overseas Trade (Exhibitions and Fairs Division), 2, Queen Anne's Gate Buildings, London, S.W. 1.

SPEAKING at the annual meeting of the Iron Trades Employers' Insurance Association, Ltd., the chairman (Mr. A. E. Seaton) said:—"We desire again to impress upon our members the necessity for their taking a really deep interest in the methods recommended for the prevention of accidents, inasmuch as there is no doubt whatever that in due course they are bound to benefit by the reduction in the number and magnitude of claims. We on our part do our best by studying efficiency in claims management whereby we keep down the cost when once the accident had led to a claim; but please bear in mind that we can practically do nothing whatever of such a nature as you all can, to prevent accidents beyond giving you sound advice. Every well-considered means of preventing accidents which can be installed in workshops and yards is some help, and it is also a great help to us if all our members would try to find employment for partially injured men on light work to enable them to get once more into normal working condition, although we appreciate how difficult it is in these days. Not only does this keep down the money cost of the claim, but we have every reason to believe that it creates a better spirit between the workman and the employer. In saying this I would remind you that we are a body of engineering and shipbuilding employers associated together to administer the Workman's Compensation Act at the lowest possible monetary cost to the industry, while at the same time not overlooking the real necessity of maintaining friendly relationships between employer and workman."

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Contents.

THE ENGINEER, May 22nd, 1925.

	PAGE
A SEVEN-DAY JOURNAL	561
THE BRITISH STEAM RAILWAY LOCOMOTIVE FROM 1825 TO 1924. No. XXI. (Illus.)	562
STEAM NOZZLE RESEARCH. (Illus.)	565
IRON AND STEEL INSTITUTE. No. II.	566
SIXTY YEARS AGO	567
THE BARKING POWER STATION. (Illus.)	568
A NEW ELECTRICITY COMMISSIONER	569
OBITUARY—J. Sampson	569
LETTERS TO THE EDITOR—	
A Method of Increasing Workshop Efficiency	569
THE EFFECT OF CAMBER ON WOOD-PAVED ROADS	570
RAILWAY STEAM CAR FOR NEW ZEALAND. (Illus.)	570
MODERN DOCK EQUIPMENT	571
VULCAN ROADLESS HALF-TRACK VEHICLE. (Illus.)	572
RADIUM FROM A CORNISH MINE	572
FOUNDRY SAND RECOVERY PLANT. (Illus.)	572
THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS	572
RAILWAY MATTERS	573
NOTES AND MEMORANDA	573
MISCELLANEA	573
LEADING ARTICLES—	
Fifty Per Cent. Cut-off Locomotives	575
The Shannon Power Scheme	575
The London County Council Tramways	576
LITERATURE	576
DIESEL LOCOMOTIVE DESIGN IN GERMANY. (Illus.)	578
THE PROBLEM OF PROFESSIONAL STATUS	579
ADJUSTABLE PARABOLIC CURVE. (Illus.)	580
SUPER-TENSION CABLE DIELECTRICS	580
SOUTH AFRICAL ENGINEERING NOTES	581
AUTOMATIC PETROL POWER PLANT. (Illus.)	582
LA CHUTE DES SEPT-LACS	582
GERMAN INDUSTRY AND COMMERCE DURING APRIL	582
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	583
Lancashire	583
Sheffield	584
North of England	584
Scotland	584
Wales and Adjoining Counties	585
CATALOGUES	585
CURRENT PRICES FOR METALS AND FUELS	586
FRENCH ENGINEERING NOTES	587
BRITISH PATENT SPECIFICATIONS. (Illus.)	587
FORTHCOMING ENGAGEMENTS	588
PERSONAL AND BUSINESS ANNOUNCEMENTS	588
CONTRACTS	588

THE ENGINEER.

MAY 22, 1925.

Fifty per Cent. Cut-off Locomotives.

NEXT to reliability comes economy, not only in maintenance, but also in operation. Broadly speaking, that statement, we think, fairly represents the primary considerations involved in locomotive design. In order to obtain the reliability so essential for regular working, simplicity in construction is probably of greatest importance; from which it naturally follows that whatever we do to improve the efficiency of the locomotive must be accomplished without greatly adding to the number of parts or to the cost. It is when viewed in this light that the importance attached to the restricted cut-off principle of working can best be realised. The principle is very simple and has been fully described in the articles which have appeared in our issues of May 8th and 15th. We may, however, briefly state that the restricted admission engine is one which, at some point of cut-off less than full gear, develops a given rated tractive force equal to that of a similar engine cutting off at some point near the end of the stroke. For the sake of clearness we can put the matter in another way. Assume two similar locomotives having a given equal weight on the drivers. One, the restricted cut-off engine, will develop a tractive force, for the same proportion of adhesive weight, as does the other when operated at full power and in full gear, which is obviously only another way of stating that both have the same factor of adhesion. The great and important difference lies in the fact that the short cut-off engine, designed, say, for 50 per cent. admission, develops its full tractive effort on a steam rate approximately 30 per cent. less than that of the ordinary locomotive at 90 per cent. cut-off. Now, if the ordinary locomotive is "linked up" so that the cut-offs for both are equal, the steam per unit of power developed by the two engines will be similar, though the short cut-off engine will still show to advantage, whilst the ordinary engine will develop a comparatively small percentage of its maximum power.

Such considerations as these would appear to have prompted the Pennsylvania Railway in 1916 to build an engine having a maximum cut-off in full gear of 50 per cent., against the 90 per cent. usually employed. In order to obtain a mean effective pressure at 50 per cent. cut-off equal to that obtainable at a longer rate, the maximum torque on the axle must be greater by 25 per cent. That necessity can, of course, be satisfied in various ways, but it was certainly a bold step on the part of the designer of the new Pennsylvania locomotive to attempt to meet it by using only two cylinders, thereby involving the employment of piston loads which, at any rate to a British point of view, are enormous. The Pennsylvania engines have cylinders no less than 30½in. in diameter, and with the high boiler pressure used the maximum piston loads amount to 182,655 lb., or 81.4 tons—four or five times that found in the biggest British engines. But for other reasons such large cylinders are out of the question here, and in this country undoubtedly the adoption of the early cut-off system would always mean the introduction of a third and possibly a fourth cylinder. That, however, would not alarm us, as multi-cylinder locomotives are already well established on our railways. The short cut-off locomotive as designed, with the exception of the small starting ports in the piston valve bushings, departs in no way from approved practice, and even these ports would be unnecessary if three cylinders were employed instead of only two. Hence we believe that the 50 per cent. cut-off system could, with every prospect of success, be tried in this country, and whilst it will be fully appreciated that the greatest advantages will always be shown in the case of shunting and goods engines, for quite apparent reasons it might also, we feel sure, be introduced for express passenger locomotives, because the extra weight of the motion parts necessary to withstand the higher piston loads would be relatively unimportant, since three or four cylinders would, as already noted, have to be employed. There is indeed, perhaps, one general argument which might be urged against the system, and that is the increase in the working steam pressure which would be required. The increase would, however, not be great. If we assume a three-cylinder engine with 20in. cylinders and 180 lb. steam pressure, the latter would only have to be raised to 215 lb., a pressure below that used on the Great Western, and less by 35 lb. than the pressure of 250 lb. carried by the Pennsylvania locomotives. Such an engine would have certain very valuable characteristics. In common with any type of locomotive working on the 50 per cent. cut-off system, it would have the valuable and important feature that it could not be operated at extravagant steam rates. At any given power output it would be more economical than an ordinary long cut-off engine and it would be more flexible, because it could be operated for longer periods of time and at higher speeds at full power if the boiler were equal to that given to the ordinary locomotive.

These points in favour of the restricted cut-off principle are worthy of serious consideration. They are not founded on theoretical computations, but have actually been proved on the road and on the testing plant. We have already shown that the employment of the 50 per cent. maximum cut-off system adds nothing to the equipment of the engine. There is, therefore, no good reason to suppose that maintenance costs should be materially higher than those of the normal engine. In these circumstances we see no reason to doubt that success would follow the adoption of this very simple method of obtaining an increase in efficiency, an efficiency which is more surely obtainable because no additional complications are involved in the design of the engine.

The Shannon Power Scheme.

SOME views on the Siemens-Schuckert Shannon power scheme, which are well worth considering before rushing headlong into this costly project, are given in a recently published booklet by Mr. Henry Jeffcott, secretary of the Water Power Resources of Ireland Sub-Committee, during the years 1918 to 1920. The grounds on which the author mainly opposes the scheme are that the limited sources of water power in Ireland are so well distributed throughout the country in relation to its demands, that it should seldom be necessary to employ a main transmission system many miles in length. Under the proposed scheme, however, it is intended to spend nearly two million pounds on a main transmission system in which some 30 per cent. of the power generated would be wasted. The suggested partial development of the Shannon would yield 198 million units in an average year, and of this output some 60 million units, it is said, would be lost in transmission. These figures relate to the first portion of the Shannon development scheme alone. The whole system, according to Mr. Jeffcott, would show still greater transmission losses. The idea of doing things on a large scale is very prevalent, but fortunately there are engineers who realise that the generation of electricity in relatively small quantities for local distribution is often very much better from the consumers, point of view. Much is made of the fact that large electricity schemes reduce the cost per kilowatt of the plant installed and the cost of operation. What really matters, however, is the price per unit of electricity sold to the consumers. Mr. Jeffcott

is obviously very much alive to the disadvantages of long-distance transmission, even when current is generated in water-power stations, and he contends that in some cases the Irish people would be better served by the utilisation of other sources of power than that of the Shannon.

Part of the Shannon power, it is interesting to note, is to be taken as far as Manor Hamilton, which is only some twelve miles from the Erne, the result being that the Shannon would send its power over a circuit some 170 miles long, whilst available power is actually close at hand. Indeed, it is ultimately intended to supply Ballyshannon and County Donegal as far as Glen Var, thus completely ignoring the water power of the Erne and of the Donegal Highlands. Is the Corrib with its storage lakes, Mr. Jeffcott asks, never to be developed, and the Galway always to depend for its electricity on the Shannon? What of the Liffey, Slaney, Lee, and many other rivers? Ultimately when the Liffey is harnessed for the supply of Dublin, of what use will large transformer stations near Dublin be, or the heavy transmission lines leading to it? The proposed transmission lines would, according to Mr. Jeffcott, run into thousands of miles, and in one case they would be carried as far as 220 miles. Some idea of what the promoters of the scheme contemplate doing in the way of transmitting power can be gathered from the fact that it is proposed to use synchronous condensers to overcome the well-known difficulties of operating long-distance lines. While the Shannon scheme has been widely criticised, no one, so far as we are aware, has dealt so thoroughly with this important matter of transmission as Mr. Jeffcott. In a country such as Ireland, where power in small but sufficient quantities could be drawn from a number of sources, it is difficult to understand why a scheme such as that which has been put forward should be entertained. What is required is a national policy of water power development, in which every source would play its part, so that the very best results could be secured. The question that should be settled is, as Mr. Jeffcott says, not whether the Shannon scheme is workable, but whether it presents the best and most economical way of developing the water power resources of Ireland. The Liffey, most engineers are agreed, should be dealt with in the first instance for the supply of power to Dublin, and other areas which require electricity should be supplied as far as possible from water powers in their immediate neighbourhood. Apart altogether from the capital and operating costs of long-distance transmission lines, there is greater liability of interruptions in the supply than there is when current is only transmitted a short distance, but with this aspect of the matter Mr. Jeffcott does not deal.

Other points discussed in the pamphlet are the reliance which Siemens-Schuckert place on the sale of current for heating purposes, the method of securing increased head and water storage by means of embankments and the cost of wiring houses and connecting them to the mains. The most forcible argument put forward against the scheme, however, seems to us to be the long distances over which the current would have to be transmitted. If there were no other sources of power available the proposals might perhaps be justified, but as the water power of Ireland is so well distributed, we consider that the Irish Government would be well advised to have the whole matter re-investigated.

The London County Council Tramways.

THE figures relating to the working of the London County Council tramways during the financial year ended March 31st last, and to the estimate of the results to be anticipated during the current year, afford anything but pleasant reading for London ratepayers. Looking back, we find that during the years 1914–1924 inclusive the tramways were run at a total net loss of £788,467. In only four years out of the eleven was there a surplus on the working, and it is open to argument whether, correctly speaking, the accounts should have shown surpluses in any of those years. That, however, is a point which we will not discuss at the moment; we have been over the ground so many times during past years. The final figures for the year 1924–25 are not yet available, but it is anticipated that the net deficit will be found to amount to £286,670, and that sum will now have to be added to the total of £788,467, which will bring the net loss, as the result of twelve years' working of the tramways, up to the huge total of over one million sterling. Nor is that all the tale! The deficit of £286,670 would have been greater by nearly £300,000 were it not for the fact that, with the consent of H.M. Treasury, the Council was permitted to postpone, for the time being, the repayment of a certain proportion of the money statutorily due for the repayment of its debt. The sum due to be repaid during the past financial year was £418,936, and that amount was included in the preliminary estimates. Actually, only £119,235 has been paid, but the remaining £299,701 will have to be repaid at some time or other. It is only putting off the evil day. There has not for some time now been any reserve fund for renewals, and the general reserve fund, which at the end of last March stood, apparently, at £40,605, has been much more than wiped out. In fact, taking it that the provisional figures are correct, a sum closely approaching £250,000 has, to square last year's accounts, to be found out of the rates, and the tramway undertaking is entirely without any reserve to fall back upon.

It is very rarely that the Highways Committee's estimate turns out to be accurate. The Committee has on so many occasions failed to make an accurate forecast that it is natural that there should be some hesitation in accepting the anticipations for the current year. Let us, however, examine them. It is estimated that, on working alone, the receipts will amount to £4,272,000, and that the working expenses, including renewals and special charges, will reach £3,980,230. That means that the working expenses will represent over 93 per cent. of the takings—a ridiculous proportion—and that the surplus on revenue account will be only £291,770. Against that surplus have to be set the debt charges, which amount altogether to £512,949. There is a credit balance from other accounts—into the composition of which we need not enter here—of £22,068, the net result being that it is estimated that there will be a deficit of £199,111 at the end of next March. The whole of that sum will have to come out of the rates, since the Council has, as we have said, now no reserve whatever. Furthermore, the £199,111 would be considerably increased were it not that, during the current year again, only a portion of the statutory amount of repayment of debt will be made. To crown everything, the Highways Committee asks for the expenditure of an additional £203,885 on capital account!

Literature.

Iron and Steel in the Industrial Revolution. By THOMAS SOUTHCLIFE ASHTON. Manchester: University Press. 1924. Price 15s.

THIS is a remarkable work on a great subject. Nominally devoted to the technical and economical development of the iron and steel industries, it is actually a vivid record of the chief inventors and founders of trades who, in one and a half centuries, changed England from her agricultural life into the foremost manufacturing country in the world. Professor Ashton deserves our hearty thanks for the research he displays in a volume which in scope, matter, and richness of treatment, takes a high place in economic literature.

"Revolution" here means the slow change from charcoal iron to mineral fuel in ironfounding, and the stimulus to the iron and other trades given by Watt's steam engine and Cort's puddling and rolling process, combined with the resulting effects on the science, industries and social conditions of the country. This work is therefore largely a study of the last quarter of the eighteenth century, that great formative time or cradle days of great inventions, discoveries and new manufactures, which entitle the period to rank with the dramatic and poetical renaissance under Queen Elizabeth and James I. An original and valuable feature is the skilful way in which the author has interwoven with his accounts of leading inventors or patentees the economic effects of the application of their inventions. Still more admirable is the precedent Professor Ashton has created—which deserves the flattery of imitation—by going, not to old text-books, but to original sources, and to the records of old firms, Boulton and Watt, and others, so that we are here presented with a high percentage of illuminating matter never before published.

Professor Ashton's sketch of the charcoal iron industry serves as an introduction to the first successful use of mineral fuel by Abraham Darby in 1709. With ample, illustrative detail, the author traces the progress of the trades based on charcoal from the Middle Ages, when malleable iron was the staple, through its great periods, like the cannon-founding industry in the Weald of Sussex, to its decline after the Civil War, and its practical extinction by the inventions of Cort. Many curious facts are quoted about the early ironmasters, mostly landowners, with native capital; the number of furnaces and forges, with particulars of processes; men, and methods employed; and the origin of casting which apparently began in Sussex, not Prussia. But astonishing as the products from charcoal were, no industry based on timber could have a secure future in this kingdom. By the sixteenth century the voracity of the ironworks had caused a shortage that threatened the future of shipbuilding. The need of substitutes, peat or coal, brought out the early pioneers of mineral fuel, represented by Dud Dudley, whose pretensions are treated with iconoclastic humour. Most interesting of all is the explanation why coal gradually became more important than ore. Professor Ashton shows this tendency counteracting the dispersion caused by charcoal, and concentrating certain trades near the coalfields, as, for example, the nail makers of Birmingham and the tool makers of the North of England.

Coalbrookdale has the distinction of being the birthplace of smelting iron with pit coal, and Professor Ashton proves who was the reel, original discoverer of the process. Many doctors have differed as to which of the "dynasty of ironmasters," the Darbys, the first Abraham or the second, was the finder of the secret. Our author has now decided the point as far as contemporary evidence can enable one to do so. His proofs, he tells us, were being read, containing an almost impregnable case for Abraham I., when he received an original letter which clinched his conclusions—see Appendix E, pages 248–50. It was written, about 1775, by Abiah Darby, oddly enough the wife of Abraham II., to whom Dr. Percy ascribed the discovery! The letter shows that the lady had an intelligent grasp of the problem; and after describing the first Abraham's various experiments, she adds: "It was my Husband's Father . . . that thought it might be practicable to smelt the Iron from the ore in the Blast Furnace with Pit Coal." The passage is too long for quotation; but that is the material part. Though Abraham II. improved the process, it is significant that his own wife does not even suggest that he had any share in the original discovery. Such a proof coming from such a deeply interested quarter may be regarded as conclusive.

Professor Ashton attributes Darby's success to a strong, continuous blast, which, produced by more powerful bellows than any in use, gave complete fusion. We refer readers of THE ENGINEER to the forty pages in which the author traces the rise of the new industry down to Cort's time, with an exuberant fertility of fact and illustration. At first the new process moved slowly. No report of it was printed till 1747, for Darby was a Quaker, and did not advertise. It started a struggle between the foundry and the forge, since British common sense insists on every new thing justifying itself. Some progress, however, was made in castings, chiefly in Shropshire until the middle of the century, when the great works at Carron and the furnace at Seaton, Workington, gave the method an outstanding advertisement. It began to spread rapidly; but such was the control of the charcoal masters that sixty years after Darby's discovery the bulk of English pig iron was still smelted by charcoal.

Yet coke in the blast-furnace created great developments in foundry products, and inspired numerous inventors. The Coalbrookdale Company itself may be taken as typical of many firms. It specialised in castings for the Newcomen Fire-engines, which, improved by the hand gear of 1718, came into general use in collieries; and a little later, most of the Fire-engine material was in its hands. The process improved and cheapened the Fire-engine, which, in turn, benefited the iron industry. As coke smelting spread to other manufactures, a gradual change began from small-scale production to what we call the "factory system." Professor Ashton illustrates this "dominating tendency of industry" by the histories of four great firms—the Darbys, the Wilkinsons, the Walkers, and the Carron Company. His account of their activities and achievements, and their influence on trade generally, rounds off a stimulating and fascinating chapter. His short note on Benjamin Huntsman, inventor of cast, or "crucible," steel, is a useful and interesting pendant to his story of the developments in cast iron.

The relations between Boulton and Watt and John Wilkinson, of Bersham, first their associate, then their "terrific antagonist" with the "iron soul," is, in Professor Ashton's pages, the modern epic of engineering. Packed with facts, many new, it is the most original and decisive contribution to Watt literature yet published, and may be called the "*histoire intime*" of the steam engine. The author has drawn his pictorial narrative from the Boulton and Watt collection at Birmingham, the Letter Books of the Soho firm, and other sources; and the result is that we seem to be behind the scenes watching the inception, birth and the trying progress to triumphant success of the Watt engines. We leave hearing the rude echoes of the dismal quarrel that ended the first, and probably greatest, partnership in invention and engineering in English history.

It may sound odd, but Boulton and Watt did not build steam engines for sale. They were designers and erectors; Soho, apparently, was our first "assembling" shop, and, happy circumstance, gave elementary lessons in mechanical engineering. Firms

desiring engines arranged with founders and smiths for materials, Soho supplying skilled labour and expert talent in difficult parts. This peculiar, but at the time lucky, division of work, Professor Ashton adroitly uses to give us a series of educative and serviceable peeps into early steam engine history. We cannot recall anything so satisfying as his accounts of the men or firms who, as producers of engine material, played leading or auxiliary parts during those evolutionary stages of the new giant power. Ironmasters, smiths or founders, sometimes as far north as Carron, specialised in making this or that part—cylinders, pistons or plates, &c. From this apprentice work, they gradually went on to build complete engines themselves, and so founded businesses that became miniature Sohos to smaller craftsmen.

Naturally, it was in the production of iron and steel that the first far-reaching, revolutionary effect of Watt's mighty invention began to change the industrial world into what we see to-day. The engines at first were chiefly used for the blast in smelting, pumping water, moving forge hammers, and, later, for rolling and slitting mills—each stage illustrating the sureness of the progress being made. When the double-acting engine began to drive milling and cotton spinning machinery, Watt's difficulties were ended; but already younger and bolder inventors than he were struggling to apply his engine to the steamship and the locomotive.

John Wilkinson's quarrel with Soho is remarkable only because of the greatness of its setting. The "eminent caster" of Bilston (*c.* 1770) was the first to make use of the new engines. For his cylinder-boring machine, which certainly crowned Watt's work with success, and led him to think himself part-inventor, he obtained a monopoly of making cylinders and other parts which lasted twenty years. Then a few trifling jealousies provoked a bitter quarrel, which a glance at Wilkinson's portrait partly explains. At the instance of his brother William, Soho proceeded against him, as the arch-pirate of all their infringers. Professor Ashton gives us a grimly humorous version of a sordid story, which moves on melodramatic lines that would delight patrons of Drury-lane or Melville drama.

Henry Cort, "the Samuel Crampton of the iron industry," is Professor Ashton's text for a very informing survey of the broader effects of steam power on the iron trades. In this respect, Cort's work was a fit pendent to the enormous enlargement of industry that was stimulated by Watt's steam engines. The fining process having proved more prodigal of fuel than the smelting process, inventors made persistent efforts to apply mineral fuel to the manufacture of bar iron. The most notable were the brothers Cranage about 1776, with their method of rendering iron malleable in a reverberatory furnace, in which they made use of something like puddling. By this method the Cranages won from charcoal the raw material for nail making, and so saved the important nail trade. "We have now" (1784), says Richard Reynolds, "to make *bar iron* with pit coal"—two months after Cort's second patent.

It was in 1783–4 that Cort, after many years of research, broke down the barrier which "sulphurous and drossy" pit coal opposed to the new method. Cort, a navy agent in London, recalls the cynical French maxim that the people in a trade seldom invent anything in it. The initial object of his experiments was to make English wrought iron as sound for naval purposes as that from the North of Europe. After describing Cort's processes, Professor Ashton remarks that though not the first to make use of coal in fining, "the fact remains that Cort was the first to combine and co-ordinate these fragmentary improvements into a single new process." Result: Fifteen tons of metal could be passed through the rollers in twelve hours; whilst a tilt hammer could only produce 1 ton in the same time, and the iron could be substituted for charcoal iron for all uses except steel making.

The immediate effect was that in ten years (1806) one hundred new furnaces were at work, collieries could not supply the demand for fuel, and the peasant forges of Northern Europe were no match for the coke refineries and rolling mills of new industrial England. Iron for nails sold at £12 per ton instead of £20; and for the first time in many generations there was no shortage of raw materials. Exports of bar iron exceeded imports fourfold, and the great number of steam engines prevented underselling or competition from any market. The author's account of the development of Cort's process by district and industry points the moral: "Apply science to industry and prosper." But it is pathetic to record that the creator of such gigantic results, second only to Watt, was ruined by his own invention.

Want of space compels us to commend the rest of Professor Ashton's profoundly interesting work to those specially interested in economic, commercial, social and political questions. Each in its way shows the reverse side of the technical medal, and all display Professor Ashton's lavish use of chapter and verse. Read in conjunction with the chapters reviewed, the reader will obtain something like a film-picture of British activities and conditions during the last two centuries.

The work is provided with portraits of Watt, Wilkinson and others; views of Coalbrookdale and Thorncliffe Works, and a map of iron centres. Everyone interested in the past and present of our industries should read this remarkable book. It will help them to understand our own confused times and encourage them to face the future with fortitude.

SHORT NOTICES.

The Testing of High-speed Internal Combustion Engines. By Arthur W. Judge. London: Chapman and Hall, Ltd. 1924. Price 25s. net.—This well-written and excellently illustrated volume is a companion book to the author's treatises on high-speed internal combustion engines and on automobile and aircraft engines. While assuming a certain knowledge of the theory of heat engines, the book is distinctly practical in character and should be of considerable use to all who have to do with engine testing. In the first chapter a *résumé* of general principles, formulæ and experimental results is given, which is followed by a chapter on test procedure. Fuel test, exhaust gas analysis, and the measurement of air, water supply and heat loss are dealt with. The chapter on the measurement of brake horse-power contains an exhaustive description of dynamometers, which is followed by an equally full consideration of different types of pressure recorders and indicators. The analysis of indicator diagrams is discussed, after which a section of the book is devoted to temperature measurements and measuring instruments. A general account of road testing for automobiles is then given, followed by a chapter on aircraft engine tests. In a short final chapter the analysis of high frequency movements by various methods is described. There is a short bibliography of books, publications and sources of reference, which is followed by four appendices, which include formulæ used in test calculations, S.A.E. engine testing forms, the Air Ministry schedule of standard type and production tests for aircraft engines, and the calculation of the quantity of air which passes through a throttle plate. A well-arranged index completes a book which we can recommend to all interested in the development of the high-speed internal combustion engine.

Cost of Power Production by Internal Combustion Engines. By G. A. Burls, M. Inst. C.E. London: Blackie and Son, Ltd. 1924. Price 5s. net.—Mr. Burls is a well-known writer on matters relating to oil engines, and his latest book is a summary of information concerning the running and installation costs of various types of internal combustion engines. He deals with large gas engines, light oil engines, and Diesel engines, and includes in his brief survey aircraft engines, petrol lorries, farm tractors, and hot-bulb marine engines. The large marine oil engine is not considered. Data covering the period just prior to the war and extending up to last year, when there was a notable fall from the high operating costs of the war period, are discussed. A feature of the book is the excellent series of tables, which give detailed particulars of various types of large gas engines. Typical industrial and power station plants are described and test results quoted from authoritative sources. In the transport section reference is made to motor omnibus and lorry performances, and an account is given of the development of the farm tractor, which, although it has recently fallen off as regards agricultural use, is again finding a place in road transport since rubber tires have been fitted. In the marine section only one type of hot-bulb motor is dealt with. Mr. Burls has gathered together some interesting figures and his book forms a useful reference volume.

Das Kalkbrennen. By Berthold Block. Verlag: Otto S. Pamer, Leipzig-Reudnitz. Price 27.50 Gold Marks.—This book on the theory and practice of lime-burning and kiln design is a second and enlarged edition. It deals with the uses of burnt lime in industry and the disposal of lime-refuse from chemical plants. After a survey of the existing types of kiln, the author discusses the fundamental and physical reactions which take place during the process of burning. A further chapter is devoted to the firing of kilns and the fuel consumptions, which are available in modern practice with solid liquid and gaseous fuels. The kinetics of the combustion process are dealt with at some length. The author then passes to a description of various kinds of shaft and rotary kilns, and the principal details of design are carefully explained. A useful part of the book is that in which the choice and testing of fire-resisting linings is discussed. Before passing to the auxiliary plant, such as blowers and pumps, a number of chapters are taken up with a consideration of the important question of the recovery of the waste gases and their purification. The final chapters of the book are devoted to a description of the practical and scientific control and running of lime-burning plants, and the warehousing and transport of products. The appendices include a bibliography, and also a list of patents which bear on the process under discussion.

The Principles of Thermodynamics. By George Birtwistle. Cambridge University Press. Price 7s. 6d. net.—To those desiring to revive their acquaintanceship with the principles of thermodynamics and to learn of its recent applications in physics, chemistry, astronomy and mechanical science, Mr. Birtwistle's ably written little work can be confidently recommended. The book is based on the substance of lectures given at Cambridge University, and deals with the fundamentals of its subject in a general, though clear and remarkably satisfactory manner. While it is naturally concerned to a considerable extent with the aspects of thermodynamics familiar to engineers, it pays attention to other sides of the subject. It discusses, for instance, the application of thermodynamics to such matters as the liquefaction of air, distillation of a mixture of two liquids, osmotic pressure, surface tension, thermo-electric phenomena and radiation. The book has a mathematical basis, as it ought to have, but the descriptive arguments are full and clear, and greatly facilitate the understanding of the mathematical passages.

The Production and Measurement of Low Pressures. By F. H. Newman, D.Sc. London: Ernest Benn, Ltd. Price 16s. net.—The production of a high vacuum is a subject which to-day is of great importance, both industrially and experimentally. On the one hand, we have the exhaustion of incandescent electric lamps, thermionic valves, Coolidge tubes, and containers for liquid air. On the other, we have the investigation of the photo-electric effect, of atomic structure and isotopes, and of the phenomenon of ionisation. It is said, indeed, that every improvement in high vacuum processes has been followed by important discoveries. Dr. Newman has therefore rendered excellent service by collecting and expounding the scattered information on the subject. He treats the matter in a thoroughly practical manner involving little mathematics, but, nevertheless, succeeds in giving full and clear accounts of the construction and working of the various types of pumps and processes for the production of high vacua and of the manometers and gauges used to measure the low pressures reached by them. Particular attention is paid to the mercury vapour diffusion pump, which the author holds will be the pump of the future.

Practical Advice to Inventors and Patentees. By C. M. Linley. London: Sir Isaac Pitman and Sons, Ltd. 1925. Price 3s. 6d.—There are many guide books for inventors. Most of them are written either by patent agents with an eye to business or by patent lawyers with an eye to litigation. Mr. Linley's book appears to be of a different kind. It is a prolonged and very readable chat on patents and patenting. It contains a great deal of sound common sense clearly expressed, and is just such a guide as one might place in the hands of the would-be patentee who is not conversant with the subject. Mr. Linley, besides giving simple but explicit directions for the preparation of specifications, touches upon the nature of inventions and has words of wisdom and encouragement for inventors.

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Bauxite and Aluminium. By W. C. Rumbold. London: John Murray, Albemarle-street, W. 1. Price 6s. net.

Steel. By J. Rouelle. Translated by A. Chapple. London: Geoffrey Bles, 22, Suffolk-street, S.W. 1. Price 5s. net.

Cast Iron. By J. Rouelle. Translated by A. Chapple. London: Geoffrey Bles, 22, Suffolk-street, S.W. 1. Price 5s. net.

Examples in Machine Design. By G. W. Bird. London: Sir Isaac Pitman, Parker-street, Kingsway, W.C. 2. Price 6s. net.

Notes on Preparing a Tender. By R. I. Money. London: The Society of Engineers, 17, Victoria-street, S.W. 1. Price 3s. net.

Ether and Reality. By Sir Oliver Lodge. London: Hodder and Stoughton, Ltd., Warwick-square, E.C. 4. Price 3s. 6d. net.

The Principles of Thermodynamics. By G. Birtwistle. London: Cambridge University Press, Fetter-lane, E.C. 4. Price 7s. 6d. net.

Electric Welding. By L. B. Wilson. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 5s. net.

Report on the National Screw Thread Commission. Revised 1924. No. 61. Washington Government Printing Office. Price 35 cents net.

Coal-mining Problems in the State of Washington. By G. Watkin Evans. Washington: Government Printing Office. Price 20 cents net.

The "Electrician" Annual Tables of Electricity Undertakings, 1925. London: Benn Brothers, Ltd., 8, Bouverie-street, E.C. 4. Price 10s. net.

L'Electrification Industrielle et Rural de la France. By E. Pacoret. Paris: La vie Technique et Industrielle, 14, Rue Seguier. Price 60f. net.

Port Administration and Operation. By Brysson Cunningham. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 13s. 6d. net.

The Empire Municipal Directory and Year Book, 1925–1926. London: *Municipal Engineering,* 8, Breams-buildings, E.C. 4. Price 10s. 6d. net.

Annales des Travaux Publics de Belgique. Deuxième Série, Tome XXVI. 1925. Bruxelles: Goemaere, Rue de la Limite, 21. Price 8.50f. net.

The Elements of Mechanics. By F. S. Carey and J. Proudman. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 8s. net.

Electricity for Everybody. Third edition. By R. Borlase Matthews. London: The Electrical Press, Ltd., 13, Fisher-street, W.C. 1. Price 7s. 6d. net.

Neue Tabellen für Exzentrisch Gedrückte Eisenbeton-querschnitte. By Dr. Ing. W. Kunze. Berlin: Julius Springer. Price 1 goldmark.

Engineering Applications of Mathematics. By W. C. Bickley. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 5s. net.

Kelly's Directory of Merchants, Manufacturers and Shippers of the World. Two volumes. London: Kelly's Directories, Ltd., 186, Strand, W.C. 2. Price 64s. net.

The Manchester Royal Exchange Directory, 1925. Compiled by R. Collinson, Ltd. London: John Heywood, Ltd., 20, St. Bride-street, E.C. 4, and Manchester. Price 21s. net.

Metallurgy of Aluminium and Aluminium Alloys. By Robert J. Anderson. New York: Henry Carey Baird and Co., Inc., 2, West Forty-fifth-street. Price 10 dollars net.

Handbook on Electro-plating, Polishing, Bronzing, Lacquering and Enamelling. Ninth edition. Birmingham: W. Canning and Co., Ltd., 133, Great Hampton-street. Price 4s. 6d. net.

Report of Mining Cases Decided by the Railway and Canal Commission Court. By P. G. Bamber. London: The *Colliery Guardian* Company, Ltd., 30, Furnival-street, E.C. 4. Price 26s. net.

Diesel Locomotive Design in Germany.

AT the recent annual meetings of the V.D.I., held in Augsburg and Munich, papers dealing with various aspects of Diesel locomotive design were read and discussed. A full account of these papers was given in the special number of the V.D.I. *Journal* of May 9th, from which the following summary is taken.

In a contribution by Dr. Josef Geiger, of Augsburg, the problem of the best type of oil engine for large locomotive work is dealt with, and various types of transmission gear are compared. The author points out the high efficiency which actual running experience shows can be obtained from the internal combustion locomotive. Thus the modern steam locomotive, fitted with the latest apparatus for heat economy and oil fired, only gives an indicated efficiency of about 7 per cent., whereas with a Diesel locomotive with electric transmission and using the same Russian fuel an indicated efficiency of 35 per cent. was recently obtained. The requirements of an oil engine which is to be used for locomotive work are in no way small. In order to obviate high axle loading its weight must not exceed 10 kilos. to 20 kilos., or, say, 22 lb. to 44 lb. per brake horse-power developed. In view of modern practice thin-walled steel castings appear to offer the best means of weight reduction. Not less important are the questions of high speed and good balancing. Equality of turning moment is very desirable, and in this respect a high-speed six-cylinder engine is shown by means of curves to be less constant for a given revolution than is a steam locomotive with twin or three cylinders. As regards flexibility, it has been shown that well-designed oil engines can develop an overload of from 20 to 25 per cent. at full speed and also at all speeds down to, say, 120 revolutions per minute. Absolute reliability of running is necessary, and self-ignition must take place when the engine is started from cold, even with large quantities of moisture in the air, as in the case of fog.

If draw-bar pull be plotted on a base of locomotive speed a hyperbolic curve is obtained which varies in form with different engine loads. It is made apparent by a consideration of such curves that draw-bar pull varies in the reverse ratio to speed, and that at starting, or when running slowly up steep gradients, outputs double that of the rated output may be required. It is not possible to supply this power by putting in a larger engine, because such conditions could only be met by the undue sacrifice of both weight and cost. Some form of intermediate transmission gear is therefore required between the engine and the driving wheels, and Dr. Geiger reviews the various systems which have been proposed and employed. Supercharging, which has been useful in the case of the aeronautical engine and the marine oil engine, gives an increase in output of from 15 to 20 per cent., which, however, is insufficient for locomotive work and is only obtained by greatly added weight and complexity. Again, supercharging means higher working pressures and cylinder temperatures, with a corresponding danger in the direction of heat transmission difficulties. Such troubles, the author thinks, may also be expected with the compound Diesel engine, in which the ordinary locomotive cylinders are employed as low-pressure cylinders. The Still system, in which steam is employed to give the added torque, is of interest, but the question of boiler working and attendance remains a problem, and some water will be required for make-up. The tests of the Still experimental locomotive which is to be built by Kitson and Co., Ltd., of Leeds, will be awaited with considerable interest.

The problem of direct transmission through gearing has been worked out by Professor Lomonossoff in a Diesel locomotive which will shortly be tested at the Hohenzollern Locomotive Works at Düsseldorf. The Diesel motor employed will consist of a 1200 brake horse-power M.A.N. engine designed for a speed of 450 revolutions per minute. The engine is coupled to a speed change gear through an elastic spring coupling and a magnetic coupling, the object of the spring coupling being to damp out some of the inequalities in turning moment and to prevent shock from being transmitted to the gear-box. The last geared axle drives a jack shaft, to which the driving wheels are coupled by means of the usual side rods. The gears comprise a set of bevels and several change gears which are made of hardened steel and are constantly in mesh. The different speeds are obtained by magnetic couplings operated from the driving cabs. The total weight of the transmission gear is, we note, about 12 tons. We hope to publish further details of this notable engine within a few months.

Gears with hydraulic transmission have been tested by the M.A.N. Company, but the results did not, in the opinion of that firm, warrant further development along these lines, at least for locomotives of large power.

The Diesel locomotive with electric transmission designed by Professor Lomonossoff and built by the Hohenzollern Locomotive Company was described in THE ENGINEER of September 19th last. The test bed trials at Esslingen were published in our issue of November 19th last, while in THE ENGINEER of February 27th this year some results of the road trials carried out in Latvia and Russia were given. Up to that time over 3000 kiloms. had been run, and since the end of February two 5000-kilom. journeys to the Caucasus with 1000-ton trains have been made according to time table without, we are informed, the slightest hitch of any kind. The test bed results have now been confirmed under practical running conditions, and on one of the Caucasian trips it was demonstrated that only one-sixth of the amount of naphtha was used which would have been required by a steam locomotive doing the same run. In spite of these successful results Dr. Geiger does not regard electric transmission as the final step in the perfecting of the oil-engined locomotive.

A direction in which further progress is possible—so Dr. Geiger thinks—is the employment of steam or air in the actual cylinders of the locomotive. Working on such a system, Cristiani uses, in a closed circuit, steam which is generatein a high-pressure boiler heated by the exhaust gases from the Diesel engine. The steam is expanded to a low pressure in the ordinary cylinders of the locomotive and is then led to a second cooler, where it is cooled to air temperature by the natural draught of the locomotive. The steam, which is then reduced to a very small volume, is compressed by a Diesel-driven compressor and is injected again into the high-pressure boiler. The system is said to give an efficiency of transmission of 82 per cent., or 72 per cent. at the rims of the driving wheels.

In the Zarlatti system the Diesel engine is used to drive an air compressor and the waste heat from the engine cooling water and exhaust is used to generate steam, which is mixed with the air in a certain proportion. The admixture of saturated steam with the compressed air is said to avoid the formation of ice in the working cylinders of the locomotive, which might conceivably take place, under certain conditions, were air to be used and expanded to a low temperature. For this method of working with the latest improvements an efficiency of transmission of 90 per cent. is said to be claimed. In Italy locomotives of both types last referred to are, we believe, under construction. In Germany the Görliz Machine Works Co., has built a small locomotive in which the exhaust gases of the oil engine were used as the medium of power transmission and a small engine of this type was exhibited at the Seddin Railway Exhibition last year.

The system with which Dr. Geiger has since 1918 been associated is that invented by him, in which air taken from the atmosphere is compressed to a high pressure and temperature by a Diesel-driven air compressor. It is then further heated by the exhaust gases from the engine and utilised in the ordinary cylinders of the steam locomotive. The efficiencies and losses at various stages in this process are shown in Fig. 2, and the figures shown are worked out for a Diesel motor with a designed output of 2100 indicated horse-power when running at a speed of 450 revolutions per minute and with a final compressed air

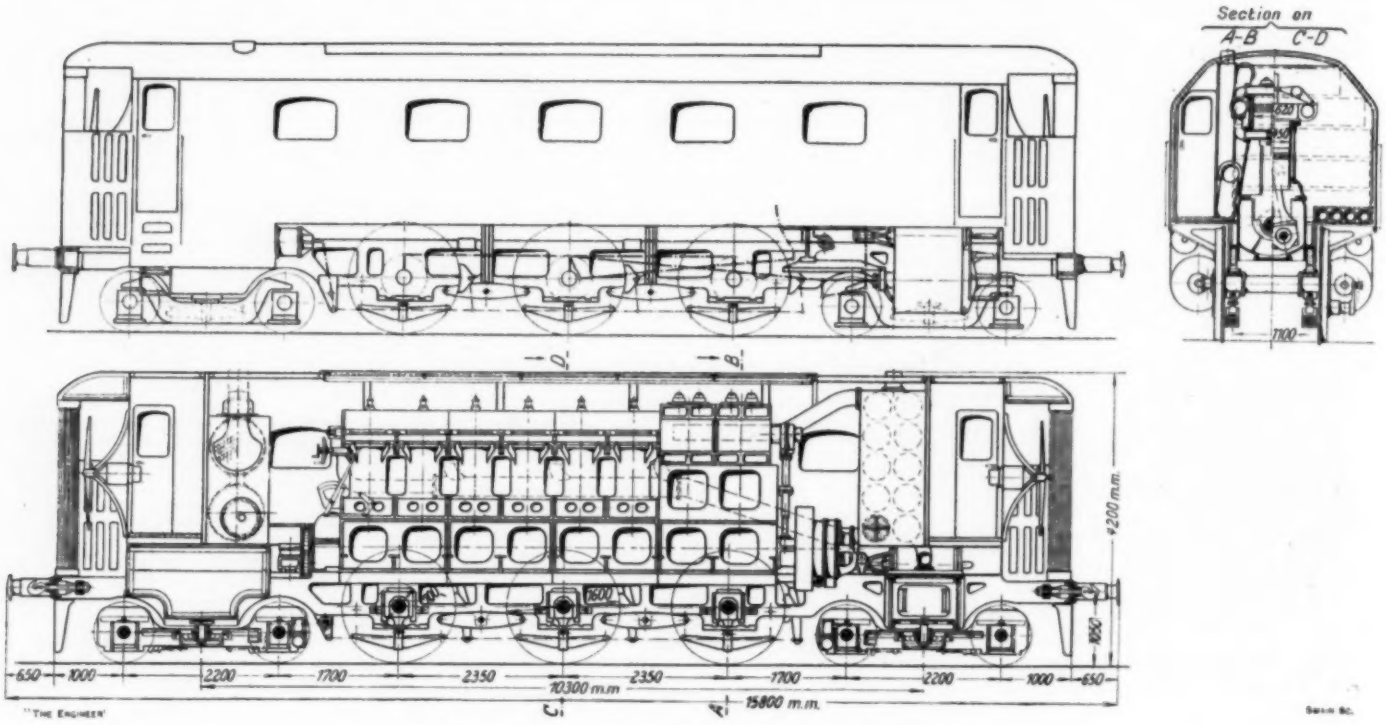


FIG. 1—DIESEL LOCOMOTIVE WITH COMPRESSED AIR TRANSMISSION

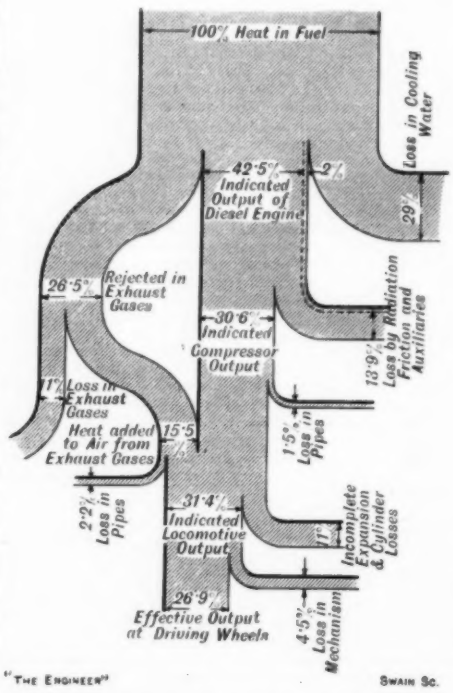


FIG. 2—HEAT FLOW DIAGRAM

pressure of 8 atmospheres, or, say, 118 lb. The estimated output at the driving wheels would be about 1300 brake horse-power. Such a system enables a close approximation to the Carnot cycle to be employed in the working cylinders and use to be made of a large temperature drop. The amount of heat added from the exhaust gases will be noted from Fig. 2. The cycle is not a closed one and cold air is taken in from the atmosphere, thus avoiding the expense and weight of the air cooler which would be required were a closed system to be employed. Experiments made in 1919 by the M.A.N. Company and again in 1923 showed that there is no danger of an explosion occurring through the ignition of lubricating oil in the locomotive cylinders, even when the cylinders are well lubricated. It is claimed for this system that it is cheaper to build than is either electrical or mechanical transmission, while the locomotive is similar to the steam locomotive in design and requires the same kind of attendance. The important element is the air compressor, and success will depend on whether a highly efficient compressor running at a high speed and with a large output can be designed and maintained in service.

A locomotive of the type we have just referred to was described and illustrated in a paper by Dr. M. Mayer, which dealt with the subject from the point of view of the locomotive builder. Fig. 1 shows a design for a Diesel locomotive with compressed air transmission which is, we understand, at present under construction at the Esslingen Machine Works. The Diesel engine shown is a six-cylinder M.A.N. unit of 1200 brake horse-power output. Dr. Mayer gives an account of the development work on Diesel locomotives carried out at Esslingen, and illustrates various designs and arrangements of oil motors for locomotives from 150 up to 3200 brake horse-power. Of particular interest are the suggestions made with a view to making the main bedplate of the Diesel engine integral with the locomotive frame. Some designs for direct transmission with mechanical gearing are also given.

Another paper, prepared by W. Schumacher, of Karlsruhe, describes in detail a 160 brake horse-power oil engine locomotive with improved Lenz transmission gear, which was built for the German State Railways. Locomotives up to 250 horse-power have been built on this system and a 1000 brake horse-power unit is to be constructed.

The Problems of Professional Status.

(By a Contributor in China.)

THE newspaper mail arrived last evening and the eagerly looked for technical journals have been carefully studied. You must live thousands of miles away from England really to appreciate the technical journals. In remote parts of the world you can discover very little of what is happening in the way of new developments in engineering except by the good offices of these most valuable and silent friends. In England you do meet the men who are making the improvements or who have recently witnessed experiments. You often learn a great deal outside of the lecture room when you attend a meeting of a technical society. A large number of engineers abroad miss that sort of thing very much indeed. "Books are all very well in their way," said the immortal R. L. Stevenson, "but they are a mighty bloodless substitute for life." Technical books are invaluable, especially for reference purposes, but they do not give the news. It is, of course, much nicer to discuss a problem than to read about it. The technical journals are more human than books. They are more alive. One would rather attend a meeting of a technical society than read about it, but it is a great boon to read about it instead of remaining in entire ignorance of what is taking place in the engineering world. And if we wait until all the current controversies are put into books, we miss a great deal and are out of date.

THE STATUS PROBLEM.

These are the days of democracy and nobody is supposed to care a button about social status. That may be so in Great Britain; it certainly does not obtain in a Crown Colony. There is an official list of ranks, in which the Navy the Army, the Civil Service and civilians figure. At any public function you are graded off according to the official list arranged by Government House. It avoids confusion, but it surprises and sometimes amuses new comers. Every one has an official status usually dependent on his work.

There were great discussions about the status of engineers in the Royal Navy, about thirty years ago, and it is not improbable that the subject will be again revived at no very distant date. Status is, of course, a matter of social ambition. The writer has always remembered the main ideas expounded in a brilliant address given to engineering students, many years ago, by Mr. Swinburne. It was entitled "Some Difficulties in Getting On." The ambitious young men were politely told by the experienced, successful and clever Mr. Swinburne that, in nearly all cases, engineers are hired, and it is seldom that the man on a salary makes a fortune. He is dependent for a living on his employer. In this age of democracy status does depend to no small extent on money. You can buy status by spending money—but not always; status in a profession is entirely different from social status.

The issue of THE ENGINEER (No. 3604), which has just arrived, has a leading article on this subject of "Status of Engineers." It causes the reader to arrive at rather depressing conclusions. One is that the status of engineers is not what it ought to be. The other is that the technical colleges are turning out too many engineering graduates. There is even the suggestion that "our universities and technical colleges" are persuading young men, who should seek other roads to fortune, to enter the engineering laboratories of the colleges. This is a sort of reaction against academic training, which is not unnatural. It may be that the colleges are turning out more engineering graduates than can be absorbed, or it may be that those who do not receive a training in an engineering college are able to undersell those who do spend three or four years of their lives and a good deal of money on a college training. If, however, the problem of the status of the engineer is to be worth consideration, then this college training is an important matter. For whether we like it or not, the social status of a young man is affected by the name of his school and whether he has attended a University. At any rate, those things count abroad, if not in democratic Britain. The lawyer, the doctor and the Civil servant consider that a university education does make a difference to a man's social status. They may be wrong, but there it is.

THE PROBLEM OF CHINA.

There is another aspect of the matter which was not discussed in THE ENGINEER's leader, but which is worth exploring. It is one which the writer ventures to believe is of supreme importance in China, and probably also in other countries. It is mixed up with the eternal problem of "the sinews of war." The new world politics is something that has to be reckoned with. There is a very intense national feeling in the various countries of Asia. The only people who are now likely to make possible the development of the vast natural resources of China are the Chinese. That is not to say that British engineers and manufacturing firms need no longer be interested in the matter. Far from it. They must inevitably benefit when China builds proper roads, extends her railways and uses machinery. They will co-operate with the Chinese. They will, however, be unable to do anything without the good will and even enthusiastic support of the Chinese. How, then, are we to obtain this enthusiasm for development work unless the intellectual Chinese have some knowledge of what engineering science can do in China?

Perhaps too much is made of the fact that many young men who are trained as engineers in colleges drift into some other kind of work. They have probably benefited by their training, even although they cannot produce the dividends on the time and money spent at college. It would not cause the writer any great grief if he were privileged to take part in the training of 300 Chinese engineering graduates per annum for the next ten years. These young men might find it impossible to obtain the lucrative posts that they would desire, but they would act as missionaries of applied science in China. Of course, their influence would be much greater if they were all drawn from wealthy families. And the wealthy Chinese, rightly or wrongly, are determined to send their sons to universities. It is an advantage to have some of them trained as engineers.

An example may be of some interest. Eight years ago one of the engineering graduates of the University of Hong Kong left to serve under a British engineer on one of the Chinese railways. Despite the initial prejudice of his technical superiors he managed to get along quite well. After a few years, he came to the conclusion that, on account of his family connections, he would make more money in official life than as an engineer on a railway. He was probably quite right. We have had many casual meetings since he became an official. He has always, in his political position, kept in mind two very important things. One is the great advantages that must come to China by the use of engineering knowledge and appliances. The other is that this Colony of Hong Kong presents an object lesson, not only of the results of applied science, but of the benefits to both nations which follow out of the co-operation between Chinese and British. Although he has not practised his profession of engineering for some years, there can be no doubt that it was a fine thing for himself and China that he was trained as an engineer.

If we could persuade the wealthy Chinese that it would pay them to introduce, let us say, roads, water supply systems, or motor omnibuses or tramcars, in the cities of the interior, they would be quite keen about it. Europeans cannot hope to convince them. Only their own sons, or brothers, or nephews can do that. They may not be very practical young engineers, but they can point out the possibilities. My Chinese friend, who is a prominent official and an engineering graduate, is always urging on his colleagues to carry out this or that public work. Twelve years ago Canton, the biggest city in China, was a city without a wheel. It was worse than the London of 300 years ago, for the streets were so narrow that two sedan chairs could scarcely pass. Now the old city walls have been pulled down and there is a "bund" or water front crowded with wheeled vehicles as well as wide roads on the foundations of the old city wall. There are rickshaws and motor cars in Canton to-day. Instead of shops with walls of mud bricks, there are five and six-storied buildings of reinforced concrete. Steel, electrical machinery and other products from factories in Europe or America have been used for these innovations. These changes have been brought about by young Chinese who have received a technical training in a University.

It must be remembered that the Chinese have still a very great respect for learning. The intellectual side of engineering admittedly appeals to the official classes much more naturally than does the practical work. Yet if you can only arouse their intellectual enthusiasm they will gladly take a definite interest in the workshops and machines.

It must be admitted that, so far as the acquisition of wealth is concerned, engineering is a disappointing profession for many who enter it with high hopes. There are big prizes, but there is great difficulty in the early years. For the same expenditure of energy a man at about thirty years of age probably would be better paid in some other line of life. It would be difficult, if desirable, to make engineering a closed profession, like medicine and the law. There has been, however, a definite movement in that direction. The word "Chartered" reminds us of the success which has come to those who wish to emphasise their professional status of engineers.

One great difficulty is that there are so many branches and subdivisions of engineering. There are also so many grades in the industrial army. Moreover, engineers are usually so engrossed in their work that they have very little time to consider questions of status; yet it is an important matter, for many engineering prospects are put forward that require sympathy and assistance from men in influential positions if they are to succeed. It may be true that during a University career a young man does not obtain the discipline or the practical experience that is so good for him. There are a good many other things that he learns. He has the opportunity, at a most malleable time of his life, to form friendships that may be very useful to him in after life.

We have the following state of affairs so far as Chinese engineers are concerned. A large number of young men, of influential families, are passing through colleges in different parts of the world with the object of studying applied science. Almost any experienced British resident in China will say that these young Chinese ought not to go abroad until they are at least twenty-three or twenty-five years of age. Therefore they should receive their academic training in applied science in the Far East. Some of those who do well at college should be encouraged to visit Great Britain in order to establish friendly and personal relations with British engineering firms. It is a fact that these young men will not go direct from school through the ordinary routine of apprenticeship in workshops in the Far East. They will not "lose face"—*i.e.*, social status—by doing the work of coolies; after a college training they will go into the workshops.

From the Chinese working classes there are drawn men who make good mechanics. These men can find work only if the initiative in developing the natural resources of China is taken by men of a higher social status. It is therefore practically certain that the rapidity of the development of the natural resources of China depends on the number of young Chinese who are attending academic instruction in technology.

It also seems to be not improbable that if the status of professional engineers all over the world is to be improved, the idea underlying the use of the word "chartered" must become general. In that case it will become the universal practice for young men with ambition to graduate at a University as the first step in a professional career as an engineer.

THE PHYSICAL CHEMISTRY OF STEEL-MAKING PROCESSES.—A symposium and general discussion on this subject will take place at a joint meeting of the Faraday Society and the Iron and Steel Institute, to be held on Monday, June 8th, from 3.30–7.30 p.m., at the Institution of Civil Engineers, London. An introductory address will be delivered by Sir Robert Hadfield, and papers will be read by Dr. A. M'Cance (Glasgow), Dr. P. MacNair (Swansea), Mr. T. P. Colclough (Rotherham), Mr. J. H. Whiteley (Stockton-on-Tees). Among those who will also take part in the discussion are Professor C. H. Desch, Dr. W. H. Hatfield, and Mr. Cosmo Johns, all of Sheffield. Communications will also be read from Mr. A. L. Feild (New York), Mr. F. T. Sisco (Dayton), and Professor J. B. Ferguson (Toronto).

ASSOCIATION OF "OLD CROMPTONIANS."—The newly formed Association of Old Cromptonians held the first dinner at the Royal Automobile Club on Friday, May 15th, when Colonel R. E. Crompton presided over fifty-three members. After the loyal toasts reminiscences of old times were exchanged. A lead-off by Colonel Crompton in his very best vein was followed by tales of engineering adventures, adaptations and extemporisings in the early days when electricity was without charts. Messrs. G. M. Clark, M.A., M. Inst. C.E., Colonel Clibborn, S. G. L. Eustace, E. J. Fox, C. O. Grimshaw, M. Inst. C.E., J. W. Meares, J. Swinburne, F.R.S., and A. A. Campbell Swinton, F.R.S., were among those who contributed stories of difficulties encountered "from China to Peru." The meeting finally gave a year's notice of the next annual dinner by making a fixture of the nearest Friday to Colonel Crompton's birthday, namely, May 28th, 1926.

Adjustable Parabolic Curve.

THE commonest curve met with in constructional engineering is the parabola, and a device for drawing accurate parabolas of various proportions should prove exceedingly useful. Such a device is here described, and has now been put on the market by W. H. Harling, 117, Moorgate, E.C. 2. The instrument, which was designed and patented by Mr. F. W. Davey, of 14, Victoria-street, Westminster, S.W. 1, consists of a flexible steel curve, constrained to the required shape by an adjustable brass lattice. The general appearance of the appliance is seen in Fig. 1, while the principle is explained by the inventor in what follows in connection with Fig. 2.

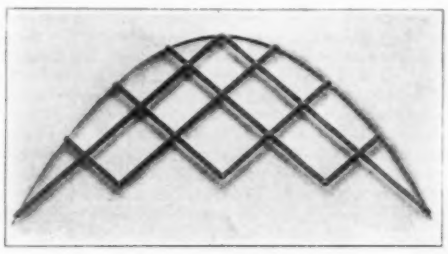


FIG. 1

In Fig. 2 let A be the vertex, P and P_1 any two points on a parabola, of which A N is the axis. Let A M and M N be equal in length, also A M_1 and M_1N_1, and let P M and P_1M_1 be of such lengths that for any one position of N, P and P_1 are on a parabola, of which A N is the axis. It is required to prove that for *any* position of N, P and P_1 will be on a parabola, of which A is the vertex and A N the axis. Draw P S and M T perpendicular to A N, and M U perpendicular to P S.

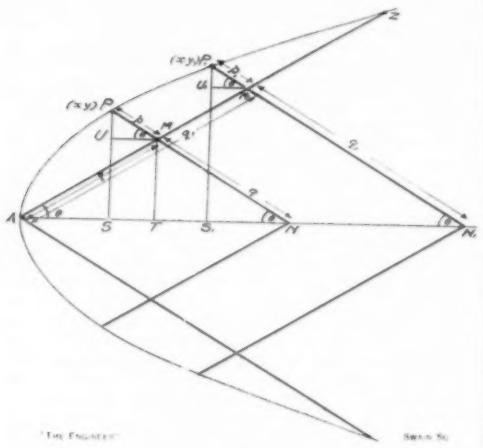


FIG. 2

Call A M $= q =$ M N, similarly A $M_1 = q_1 = M_1N_1$,
and P M $= p$, and $P_1M_1 = p_1$,
and the angle M A N $= \theta$.

Since A M $=$ M N and M U is parallel to A N, then the angle M N A $=$ the angle P M U $=$ the angle $P_1M_1U_1$ $=$ the angle $M_1N_1A = \theta$.

Now the co-ordinates of P with respect to A are—

x = A S = A T − S T = $\cos\theta\,(q - p)$ and y = P S = P U + U S = $\sin\theta\,(q + p)$.

Similarly, the co-ordinates of P_1 are—

$x_1 = \cos\theta\,(q_1 - p_1)$ and $y_1 = \sin\theta\,(q_1 + p_1)$.

Now, since the lengths p, p_1, q, q_1 have been arranged so that for this *one* position of N, P and P_1 are on a parabola with vertex A and axis A N; then—

$$\frac{y^2}{x} = \frac{y_1^2}{x_1}$$

i.e., $$\frac{(q+p)^2 \cdot \sin^2\theta}{(q-p)\cdot\cos\theta} = \frac{(q_1+p_1)^2\cdot\sin^2\theta}{(q_1-p_1)\cdot\cos\theta}$$

or $$\frac{(q+p)^3}{(q-p)} = \frac{(q_1+p_1)^2}{(q_1-p_1)} \quad . \quad . \quad (1)$$

Now let θ be changed to θ_1 by moving N along the axis A N. As before—

$x = \cos\theta_1\,(q - p)$ and $y = \sin\theta_1\,(q + p)$
$x_1 = \cos\theta_1\,(q_1 - p_1)$ and $y_1 = \sin\theta_1\,(q_1 + p_1)$

$$\frac{y^2}{x} = \frac{(q+p)^2}{(q-p)}\cdot\sin^2\theta_1\cdot\cos\theta_1 \text{ and } \frac{y_1^2}{x_1} = \frac{(q_1+p_1)^2}{(q_1-p_1)}\cdot\sin^2\theta_1\cdot\cos\theta_1$$

But $\frac{(q+p)^2}{(q-p)} = \frac{(q_1+p_1)^2}{(q_1-p_1)}$ by equation (1).

$$\therefore \frac{y^2}{x} = \frac{y_1^2}{x_1}$$

∴ P and P_1 are still on a parabola of vertex A and axis A N, however θ is changed.

It is clear that the end Z of the bar A M, providing length A Z is properly calculated, will also be on the parabola since it forms a special case when $p = o$. It is also clear that the above analysis holds for all curves having the general form $y^n = k\,x$. Thus, if the lengths p are properly calculated for the curve $y = 6\,x^{-1}$, then by moving point N, any curve of the form $y = B\,x^{-1}$ may be obtained, which, of course, is a series of rectangular hyperbolas. A new instrument, obviously, would be needed for each value of the index n.

Again, returning to the parabola, any curve of the form $y = A\,x^2$ is obtainable. By moving the vertex a distance C up the y axis, any curve of the form $y = A\,x^2 + C$ is obtainable. Also any curve $y = A\,x^2 + B\,x$ is the same curve as $y = A\,x^2$ with its vertex at the point—

$$\left(x = \frac{-B}{2A},\ y = \frac{-B^2}{4A}\right)$$

the axis being parallel to the y axis. It is thus clear that any curve of the form $y = A\,x^2 + B\,x + C$ can be obtained.

It is interesting to note in passing, Mr. Davey adds, that as N moves along A N, P describes an ellipse of semi-major axis $(q + p)$, and semi-minor axis $(q - p)$, since—

$$\frac{x^2}{(q-p)^2} + \frac{y^2}{(q+p)^2} = \cos^2\theta\cdot\frac{(q-p)^2}{(q-p)^2} + \sin^2\theta\cdot\frac{(q+p)^2}{(q+p)^2} = 1.$$

In some problems it is essential for the axis of the parabola to be perpendicular to some line. That may be done by keeping the ends of the steel strip against a T square, as shown in Fig. 3.

The average engineer or draughtsman will, of course, devise his own particular methods of using the instrument,

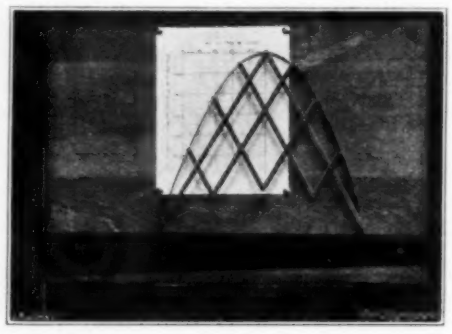


FIG. 3

but Mr. Davey gives the following typical examples to show its wide range of application.

(1) *Reference Curves.*—The following are among the curves which are parabolic in form:—

Earth pressures plotted against depth.
Wind pressures plotted against velocity.
Weight of bridges plotted against span (for preliminary calculations only).
Reinforced concrete curves, *e.g.*, those given by Turneaure and Maurer.
And many others.

As an example, the first is plotted as follows:—

Let h = height of wall in feet.
P = total pressure in lb. per foot run at $\frac{1}{3}$ h.
W = weight of earth per cubic foot.
φ and θ = angles of repose and surcharge respectively.

Then $$P = h^2 \cdot w \cdot \frac{\cos\theta}{2}\cdot\frac{\cos\theta - \sqrt{\cos^2\theta - \cos^2\varphi}}{\cos\theta + \sqrt{\cos^2\theta - \cos^2\varphi}}$$

(Rankine).

For moist loam at a slope of 1½ to 1, this works out—
as P $= 12 \times h^2$ lb. per foot run at $\frac{1}{3}$ h.
i.e., if $h =$ 0ft. P = 0 lb.
if $h =$ 40ft. P = 19,200 lb.

The method of drawing will be readily understood from Fig. 3. The vertex of the parabola is put at the point (0 . 0), and the brass lattice adjusted till the steel spring passes through the point computed above. The ends of the steel strip resting on the T square ensure that the axis of the parabola is vertical. Similar curves should be drawn for other types of earth and other angles of surcharge.

(2) *Use in Estimating Quantities.*—The integral curve of a triangle is a parabola, and this fact suggests several labour-saving methods of estimating certain quantities. As an example, the quantities for a railway cutting or embankment may be taken. Consider the fill shown in Fig. 4, the slope of which is 1½ to 1. It consists of a rectangular portion $a\,b\,c\,d$ and a triangular portion equal to the sum of $a\,e\,c$ and $b\,d\,f$. For any height h the cross-sectional area of the former will be $b.h.$ square feet and of the latter $1\frac{1}{2}\,h^2$ square feet.

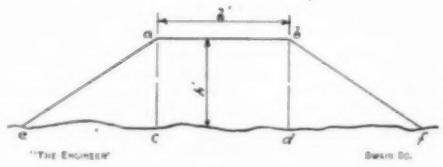


FIG. 4

A diagram—Fig. 5—is constructed by computing $b.h.$ and $1\frac{1}{2}\,h^2$ for $h =$ say, 50ft.

A B is made equal to 50ft., B C equal to $b \times h \times \frac{100}{27}$ cubic yards, and B D equal to $1\frac{1}{2}\,h^2 \times \frac{100}{27}$ cubic yards, in this case 13,900 cubic yards.

A C is joined and produced, and a parabola drawn with vertex at A and axis horizontal, passing through D. Then clearly for any height A P, M N gives the value of the embankment in cubic yards per 100ft. length.

(3) *Use in Solving Structural Problems.*—It is in this direction that the most important use of the curve will be found. The lengths of cover plates of plate girders or of reinforcing bars in ferro-concrete beams may be determined with very little labour, merely by calculating the maximum B.M., drawing a parabola through this with the curve and plotting the resisting moment in the usual way.

In continuous beams with uniform load, the complete bending moment diagram can be drawn, and points of inflexion accurately found—and hence shears and reactions—immediately the moments at the supports are computed or obtained. In these cases it is important to keep the axis of the parabola vertical, which is done by always resting the ends of the steel strip on the edge of a T square and sliding the latter up and down until the parabola passes through the required points.

As an example of its use in the case of moving loads,

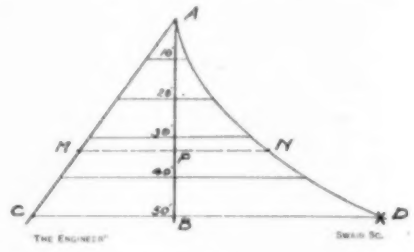


FIG. 5

take the case of a Pratt truss under a moving load of W lb. per foot. It is required to find the maximum stress in each diagonal. It may be shown that this stress $P = \frac{1}{h}\left(\frac{W}{2}\,\frac{C^2 . S}{n-1}\right)$ where the symbols have meanings, as shown in Fig. 6.

This gives a set of points A, B, C, &c., on a parabola, the vertex of which is at the last bay but one, and the maximum value of which at A $= \frac{1}{h}\left(\frac{W}{2}\cdot s\,.\,n-1\right)$

When it is drawn, the actual curve for maximum live load shear, A b B c C, &c., can be drawn, and the latter, combined with the dead load shear curve M N n O o P p, &c., of course, determines the maximum stress in the diagonals.

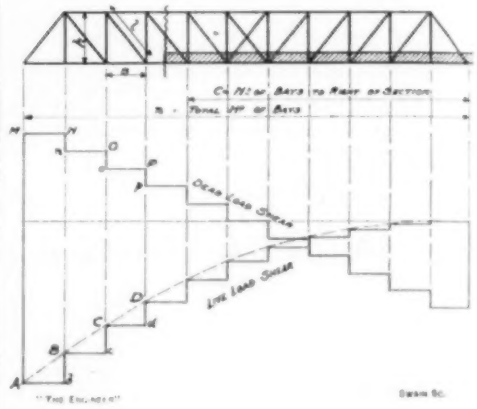


FIG. 6

(4) *Finally.*—It is suggested that the instrument may prove useful in architectural work, when it is desired to reproduce or enlarge curves with exactness. At present, shapes composed of straight lines and circles may be specified and reproduced or enlarged by workshop methods. Now, the parabola is also a curve capable of being so manipulated and thus greatly extends the means at the disposal of a draughtsman for designing pleasing forms and details.

Super-Tension Cable Dielectrics.

A GOOD deal of attention is being paid at the present time to the design and construction of super-tension cables, and on Friday, February 6th, Mr. A. I. Tracey, of Johnson and Phillips, Ld., delivered an interesting lecture on the subject before the Electrical Power Engineers' Association at the headquarters of the Institution of Electrical Engineers. The purpose of the lecture was to discuss briefly the stresses and losses which occur in the dielectric of super-tension cables, and to show how they operate and their effect upon the breakdown of the dielectric. The electric field in a single conductor cable, the lecturer explained, is not uniform, but radial, and the dielectric stress at any point in the dielectric surrounding, such as a conductor when a voltage is applied between the conductor and sheath, can be expressed by—

$$S = \frac{V}{x \log_e \frac{R}{r}} = \frac{.434\,V}{x \log_{10} \frac{R}{r}}$$

where S is the dielectric stress at a distance x from the centre of the conductor, V the voltage between the conductor and sheath, R the radius of insulation, and r the radius of the conductor. It was a fact, Mr. Tracey said, that the maximum stress occurred at the surface of the conductor, as shown by the formula—

$$S_r = \frac{V}{r \log_e \frac{R}{r}}$$

and the minimum stress at the surface of the dielectric, as shown by the formula—

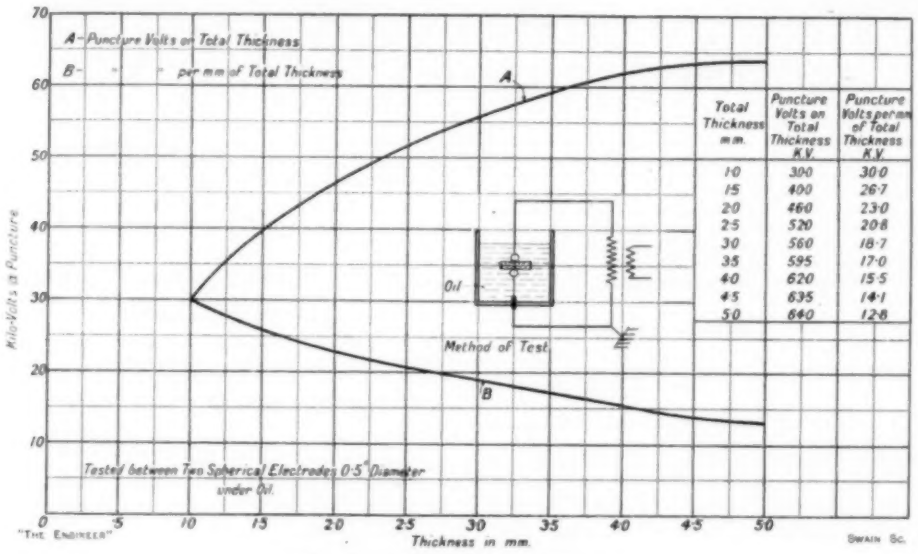
$$S_R = \frac{V}{R \log_e \frac{R}{r}}$$

If the radius of the conductor were varied, whilst the

radius of the dielectric were kept constant it would be found that the calculated value of S was a maximum when $\frac{R}{r} = 2.72$, the napierian logarithmic base.

The dielectric strength of solid dielectrics was often expressed by the disruptive voltage gradient in a uniform field in kilovolts per centimetre or millimetre or per mil. Such an expression, however, was meaningless unless accompanied by a statement of the thickness of the dielectric to which it applied, as the dielectric strength of solids varied enormously with the thickness.

The fact could be proved by taking a dielectric and subjecting it to electrical stresses and by observing the voltage necessary to break down varying thickness of the dielectric. That could be done by applying a voltage to sheets of insulation of various thicknesses by means of spherical electrodes, whilst on round conductors with varying radial thicknesses of dielectric the voltage could be applied between the conductor and a metal sheath outside the dielectric, so as to approximate the conditions of a working cable. The results obtained, the lecturer explained, would prove conclusively that the dielectric strength of solid dielectrics varied enormously with the thickness. The lecturer described a series of tests carried out with (*a*) a solid comparatively homogeneous dielectric, *i.e.*, vulcanised bitumen, and (*b*) a decidedly heterogeneous dielectric in the form of an impregnated paper of a cable. Varying thicknesses of the homogeneous dielectric were punctured between two spherical electrodes, $\frac{1}{2}$in. in diameter, and it was found that the dielectric strength fell off enormously as the thickness was increased. Two curves were shown to illustrate this effect, and one of them is reproduced below. Various thicknesses of the homogeneous dielectric, the lecturer explained, had been applied to copper rods of varying diameters, and the voltage was raised until puncture occurred. The maximum stresses at breakdown in kilovolts per millimetre had been calculated by the formulæ given, and it was again found that the dielectric strength varied with the thickness.



Total Thickness mm.	Puncture Volts on Total Thickness K.V.	Puncture Volts per mm of Total Thickness K.V.
10	300	30·0
15	400	26·7
20	460	23·0
25	520	20·8
30	560	18·7
35	595	17·0
40	620	15·5
45	635	14·1
50	640	12·8

DIELECTRIC STRENGTH AND THICKNESS

In the case of the impregnated paper dielectric puncture tests were taken on one size of conductor with varying radial thickness of dielectric and with one radial thickness of dielectric on various-sized conductors. In view of the extreme difficulty of avoiding the entrance of air between the layers of an impregnated paper dielectric, no attempts were made to carry out puncture tests on flat slabs between spherical electrodes. All the tests were taken on conductors which had been tightly paper-lapped, vacuum-dried and impregnated in the usual manner. The results obtained showed very clearly that the dielectric strength, expressed in kilovolts per unit of thickness, was meaningless unless accompanied by a statement of the thickness of the dielectric and the dimensions of the conductor.

There were two factors to be considered in dielectrics—the electrical conductivity and the dielectric losses in an alternating field. The dielectric had an appreciable, though usually very low, conductivity, which, however, increased considerably with temperature, in fact almost exponentially, so that at high temperatures the dielectric might become a fair conductor. Under an alternating voltage losses occurred in the dielectric somewhat in the nature of a dielectric hysteresis. Those dielectric losses might be represented by an energy current and an effective conductivity of dielectric hysteresis and lead to a power factor of the dielectric. If the energy current of the dielectric losses was proportional to the frequency and to the voltage and the dielectric power loss therefore proportional to the frequency and the square of the voltage, then the power factor of the dielectric circuit would be constant and independent of the frequency and the voltage. An increase of power factor with increase in voltage indicated losses increasing faster than the square of the voltage, such as losses due to ionisation of occluded gases in the dielectric, whilst a decrease of power factor with increasing frequency indicated losses increasing less than proportionally to the frequency, such as constant ohmic conduction losses. Observation of the power factor was therefore one means of judging the nature of the losses in the dielectric.

It was very doubtful if a true dielectric strength of a solid dielectric actually existed, for puncture of a solid dielectric probably always occurred in practice as the result of a more or less progressive deterioration far below the true dielectric strength. The mechanism of a breakdown of a dielectric under electric stress might be thermal, mechanical, physical, &c. If a layer of solid dielectric were exposed to a constant direct-current voltage by placing it between two conducting electrodes a current would flow through it as a result of the slight conductivity of the dielectric, the result being a consumption of electrical energy and a rise in temperature of the dielectric, and as no material could be absolutely homogeneous, the layer of the dielectric would have some spots of a slightly higher conductivity. At those spots the current density would be slightly greater, thus giving a local high temperature rise. If the conductivity of the dielectric increased very rapidly with increasing temperature it would result in a higher current density, a higher energy consumption, and heat production, and therefore temperature rise, and so on. If the heat produced in the dielectric was greater than the heat which could be conducted away from the hot spot the temperature would continue to rise and the conductivity to increase indefinitely until the energy concentration at the hot spot became destructive and the dielectric was destroyed by puncture. As the energy consumed by the conduction current varied with the square of the voltage, there was a definite voltage at which puncture occurred, and that voltage was the break-down voltage, the voltage gradient being the dielectric strength of the material under test.

The lecturer then went on to show that when a dielectric encloses a particle of relatively high conductivity or high specific capacity an electric field will exert a mechanical force on this particle, tending to elongate it in the direction of the electric field and compress it at right angles thereto.

Occluded moisture moving under electrostatic forces through the pores of the solid dielectric might form a conducting bridge between the terminals and start destruction of the dielectric, or the moisture might partially bridge the dielectric and locally short-circuit the field, causing excessive dielectric stresses in the part of the dielectric in series with the moisture bridge. If the impregnating material in impregnated insulation were viscous, movements of the impregnating material through the insulation might result from the mechanical forces caused by the differences of specific capacity or conductivity of the materials and lead to redistribution of the impregnating materials. Suppose, the lecturer said, the dielectric contained a particle of relatively high specific capacity or high conductivity capable of short-circuiting a portion of the electric field, then the intensity of the field inside the particle was much greater than in the surrounding dielectric, and in the dielectric adjacent to the edges of such an enclosed particle very high voltage gradients would occur, which might be far beyond the dielectric strength of the material and would lead to local breakdown

The lecturer concluded by dealing, among other things, with ionisation, corona in air spaces, dielectric strength and time lag, electric field of force, and calculations of stresses in three-phase cables.

South African Engineering Notes.

U.S.A. Rails for the Union.

On April 8th the steamship King Gruffydd arrived at Cape Town from Mobile, U.S.A., with a full cargo of steel rails for the Railway Administration of the Union of South Africa. The total quantity of rails, maintenance and permanent way material, was over 7000 tons, of which 2400 tons were for Cape Town and the balance for Port Elizabeth, East London and Durban.

New African Lake.

The dam near Broken Hill (Rhodesia) the water held up by which will supply power for the electric current to be carried 38 miles to the Broken Hill Development Company's lead mine, is complete, and, with recent rains, is completely full. It has created a new African lake, about 15 miles long by 2 miles wide.

Union Orders Go To Germany.

It is stated that the Maffei Works at Munich have secured an order for 21 locomotives for the South African Railways, priced at between £6000 and £7000 each, which is about two-thirds of the English price. A firm in Upper Silesia is negotiating for another order from South Africa for 80 railway carriages, at prices, so it is said, of about half those of the English tender.

Union Air Mail Service.

The air mail service instituted by the Government of the Union of South Africa, for the purpose of expediting the delivery of the oversea mails arriving at Cape Town, is proving a success, despite its having had to contend with very bad weather and heavy fogs at the start. The air mails run in connection with the arriving and departing mail steamers at Cape Town. The aeroplanes fly between Cape Town and Durban, calling at intermediate coastal towns, and the trip is being done in about 8 to 10 hours. It is calculated that the Union will save tens of thousands annually. The banks, in particular, will benefit, as they will often save a week's interest on drafts which, but for the air mail service, would not catch the mail steamer for that particular week, and would therefore have to wait for the next boat.

Demands for New Railways.

In the House of Assembly of the Union of South Africa, a number of members are pressing the claims of various districts for railway communications. It is estimated that the total length of the lines asked for would be 3503 miles, and the cost of the undertakings would be £15,000,000. The Minister of Railways has stated that since Union 2452 miles of branch lines had been constructed, at a cost of £10,000,000. A railway construction scheme was to be introduced, and he hoped to lay the programme before the House towards the end of May.

Mineral Output in 1924.

During 1924 the total production of gold was 627,729 fine ounces, valued at £2,939,562, a decrease of 19,762 oz., but an increase in value of £30,403, as compared with previous year. The increase in value is due to the average premium being higher in 1924 than in 1923. The total production of all other metals and minerals in 1924 amounted to £1,538,937, being an increase of £147,444, as compared with the previous year. During the year an increase in production was shown by silver, mica, chrome asbestos and coal.

A Large Mine Fan.

What is thought to be the largest fan in the world is at present being erected and will shortly be completed, at the Government Areas, gold mine, Brakpan. It will be 30ft. in diameter, will carry eight blades, each 10ft. across, and its capacity is to be 900,000 cubic feet of air per minute, with a 7in. water gauge. A direct-coupled single-tandem compound steam engine of 1500 horse-power will turn it at 120 revolutions a minute. The fan will be situated above a circular shaft 3500ft. deep and 22½ft. in diameter, and will draw out foul gases and used air from the entire underground works of the mine. The fan was constructed in England in accordance with special plans.

A Quarter's Gold Output.

The quantity of gold produced in the Transvaal during the first quarter of 1925 was 2,403,086 oz., compared with 2,353,056 oz. for the corresponding quarter of 1924, an increase of 50,030 oz. The value, however, at £10,131,953 was considerably less than for the March quarter of 1924, which was £10,866,259. The drop of £734,306 is due to the fact that during the March quarter of 1925 the value of gold was taken at the standard price, there being now no premium, whereas for the March quarter of 1924 the average price at which gold was valued was £4 16s., or about 11s. above par.

Device for Handling Grain.

In the absence of an elevator, Durban shipping experts have been much exercised over the prospects of the port handling of grain in bulk this season. A firm at that port has now designed a device which it is expected will enable Durban to cope with her fair share of the record maize crop which the Union expects to have this year. The device consists of a wooden box, 6ft. by 6ft. by 3ft., with a narrow door running the whole length of one side. This box can be placed under the door of a railway truck, so that the maize is emptied direct into it, and it is then swung by crane to the edge of the ship's hold. The capacity of the box is two and a-quarter tons of grain. When the door is opened the whole quantity can be emptied in a few seconds, and in this way it is claimed that the box can load 100 tons an hour.

BRITISH railways have usually been controlled by what is known as the departmental system, in contrast with the divisional system as adopted, in particular, in the United States. The former is, briefly, centralisation of administration at headquarters, the latter places the authority with the chiefs of divisions. As the recent report of the Indian Railway Board said, "The departmental system of administration, the result of gradual development from primitive methods of railway operation, has become unsuited to the working of dense traffic over large areas, and the burden on headquarters staff, owing to the centralisation inherent in a departmental organisation, is now so heavy that efficient control is difficult." The Great Indian Peninsula put a divisional organisation into work on November 1st, 1922, and it is reported that it has proved an unqualified success. Working expenses were reduced from 91 per cent. of the earnings in 1921–22 to 67 per cent. in 1923–24. Moreover, while in the former year that company had to borrow from other railways a daily average of 1203 wagons, in 1923–24 it carried about the same volume of traffic and yet lent a daily average of 35 wagons to other lines. The substitution of divisional for departmental administration is now in hand on the North-Western and Oudh and Rohilkhand Railways. The Bengal-Nagpur is to be reorganised, and as a step towards that end the department of the chief traffic manager has been divided into "commercial" and "transportation" departments.

AN AUTOMATIC PETROL POWER PLANT

DANIEL ADAMSON AND CO., LIMITED, DUKINFIELD, MANCHESTER, ENGINEERS

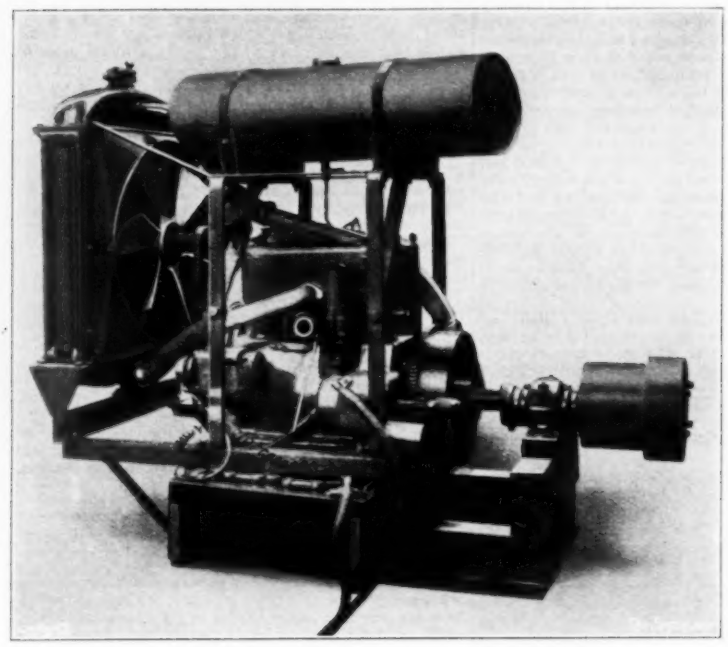


FIG. 1

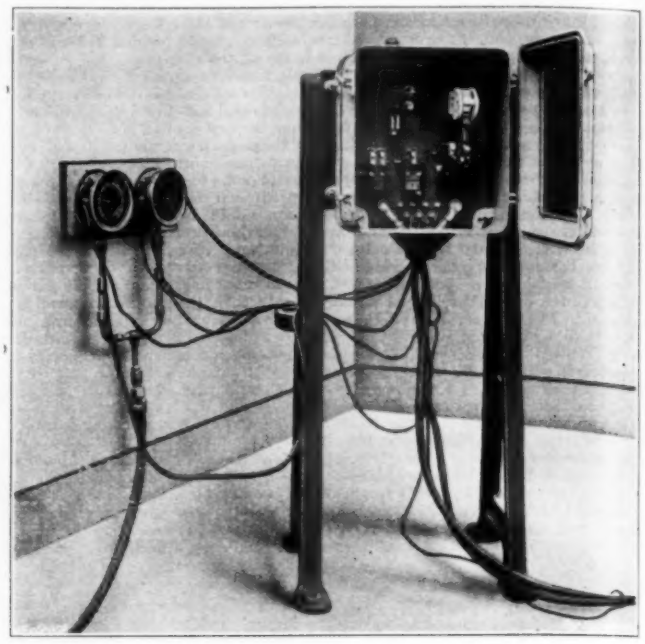


FIG. 2

Automatic Petrol Power Plant.

THE automatic power plant illustrated herewith is being put on the market by Daniel Adamson and Co., Ld., Dukinfield, near Manchester. The power unit comprises a four-cylinder vertical petrol engine, with cylinders, 3¾in. bore and 5in. stroke, designed to develop 35 brake horse-power, at a speed of 2000 revolutions per minute—Fig. 1. It is carried in a built-up iron framework, which also supports the radiator and petrol tank, and is fitted with an electric self-starter, which is operated by an accumulator battery. On an extension of the crank shaft is a combined clutch and belt pulley for driving pumps or compressors. The plant is intended for lifting water or sewage, by means of compressed air, or for use in connection with gas supplies for maintaining pressure in the mains, &c. The engine is designed in accordance with orthodox motor car practice. The lubrication system, for instance, is of the constant level circulating type, in which lubrication is accomplished by the splash of the connecting-rod splash pins in oil contained in troughs in the false bottom of the bed-plate, the supply being renewed by a circulating pump mounted in the engine base. A reservoir, which holds sufficient lubricant for constant running, is provided, and a gauge shows the quantity of oil in this reservoir at all times. The oil pump, which is of the plunger type, is operated by a cam on the cam shaft of the engine, and receives its supply through a strainer immersed in the oil in the pan. The oil is drawn through the strainer to the pump, by which it is forced through the oil tell-tale, whence it is returned to cups over the main bearings in the engine. The cooling of the engine is effected on the thermo-siphon system, the cooling action of the radiator being augmented by means of a belt-driven fan.

The electric power for starting the engine is generated by a small dynamo driven from the engine by means of a chain and sprocket wheel, the dynamo charging a battery of accumulators, which is attached to the side of the engine by means of brackets. Overcharging the accumulators is prevented by means of an automatic cut-out. The small electric motor for starting the engine receives its supply of energy from the accumulators by automatic control gear, which may be operated by floats, air pressure, hydraulic pressure, vacuum, tappet switches or temperature, so that at predetermined conditions the engine-starting motor is energised, and then automatically cut out when the engine has been started. The ignition system is high tension, with a self-contained magneto. When it is desired to stop the engine the electric control gear automatically cuts out the magneto, thus causing the engine to shut down. There is a sensitive governor, which automatically adjusts the supply of fuel according to the load. The engine is started in a manner similar to that used for starting motor cars, except that a pressure regulator with electric contact or other like device takes the place of the pedal switch.

The "Igranic" electric control equipment—Fig. 2—consists of three pieces of apparatus, a dial type pressure regulator, a control panel, and a centrifugal governor with its switch. The control panel consists of a slate base, having mounted on it a single-pole contactor switch, with magneto blow-out, which is capable of carrying 250 ampères, and which is operated by a relay, also mounted on the panel, which is controlled by the pressure regulator. The panel is also fitted with an adjustable time limit overload release to protect the starting motor. The method of operation is as follows:—When, for instance, the pressure in an air receiver falls to a predetermined limit, the needle on the pressure regulator makes a contact that closes the relay, which, in turn, closes a large automatic clapper switch, thereby connecting the starting motor to the accumulator. When the engine runs up to speed a centrifugal governor opens the switch and shuts down the electric starting motor. As the pressure rises in the air receiver, the needle travels across the dial of the regulator, and when the desired pressure is reached another electric contact is made which earths the magneto and stops the engine. When the pressure drops again, the cycle of operations is repeated. In other cases, a float switch is used for starting and stopping the electric starting motor at predetermined water levels in a reservoir or sump. A time switch may also be used for starting and stopping when desired, whilst an electric mercury thermometer control device can be attached to start and stop the electric starting motor at given temperatures.

La Chute des Sept-Lacs.

IN the *massif* of Belledone, which rises to an elevation of 2981 m. between the valley of the Isère and that of its tributary the Romanche, and near the watershed of their basins, there is a kind of plateau at an average altitude of about 2000 m. on which are several lakes, the more important being seven in number, and giving to the region the name "Sept-Lacs." Three of these lakes, Carré, at altitude 2121.3 m.; Cotepen, at altitude 2125 m.; and de la Motte, at altitude 2130 m., lie near each other, and, as far back as 1892, their potential value as reservoirs was recognised. In 1905, the Société Générale de Force et de la Lumière, having acquired the right of exploitation, made investigations, which showed that a flow of 15 million cubic metres could be utilised, a storage of nearly 8.7 million c.m. being provided by the three lakes. The actual flows of five years, 1906–1910, were, in millions of cubic metres, 17.6, 15.2, 11.5, 29.2, and 27.7. The depths available are 30 m. in lakes Carré and Cotepen and 5 m. in de la Motte. The programme of utilisation of the hydro-electric power is, for 10-hour days, 14,900 water horse-power from November to February inclusive, the storage falling from 7.54 millions of cubic metres to 3.07 millions; 10,500 horse-power during March and April, the storage falling to 1.5 million cubic metres; 8500 horse-power from May to August inclusive, the storage rising to 8.7 millions; and 10,470 horse-power during September and October, the storage falling to 8.36 million cubic metres. The available heads are 946 m. in the first of those periods, 1000 m. in the second and fourth, and 1010 m. in the third.

The power station is situated at an elevation of 1083 m., and the total head averages about 1032 m.

The works, which are described in *Le Génie Civil* of April 25th, include a tunnel 1.65 by 2 m. in section and 200 m. long; for emptying L. Carré to altitude 2100 m. in order to facilitate the driving of a tunnel connecting this lake with L. Cotepen. The latter tunnel has also a section 1.65 by 2 m., and is about 300 m. in length, mostly in compact granite. The connection from L. de la Motte to L. Cotepen is an open canal. The natural levels of the lakes, already noted, have been raised to altitude 2130 by a dam of large granite blocks with cement mortar joints. It is 190 m. long and 9 m. in maximum height.

A barrier of rock divides L. Cotepen into two parts at a depth of 22 m., and if it should be necessary to make sure of the availability of all the water between this level and the lowest level, 8 m. lower, resort may be had to syphoning. The first part of the pressure pipe is in a tunnel 1600 m. in length, 2.10 m. wide, and 1.9 m. high, and nearly 2 kiloms. of the pipe, the remaining length, are in the open. The diameter is 850 mm. between altitude 2100 and altitude 1832; 700 mm. between altitude 1832 and altitude 1610; 650 mm., 1610 to 1395; 600 mm., 1395 to 1327; and 520 mm., 1327 to 1081. The final thickness of the pipe wall is 35 mm. At present the maximum supply is 800 litres p.s., but the pressure pipe will eventually be duplicated.

The power now being utilised is developed by two turbo-generator sets, each consisting of a Pelton wheel and a continuous current dynamo, for which the main data are:—Wheel, actual head, 963 m.; normal supply of water, 380 litres p.s.; normal power, 4000 horse-power: maximum, 5000 horse-power; speed, 428 revolutions per minute; efficiency, 82 per cent.; dynamo, normal output, 2400 kilowatts; maximum, 2740; efficiency, 93 per cent.

German Industry and Commerce During April.

THE Commercial Secretary at Berlin (Mr. J. W. F. Thelwall) has forwarded to the Department of Overseas Trade a review based on the reports of the Prussian Chambers of Commerce of the trade and industry of Germany during April, 1925. From it we take the following paragraphs.

Opinion regarding the economic situation in April is not uniform. Although, on the one hand, there were indications of an improvement, particularly in the iron and machinery industry and in the electro-technical industry, on the other hand the serious sales crisis in the coal industry continued, depression still prevailed in the shipbuilding industry, and the trade balance was again unfavourable, though it improved somewhat as compared with March.

Mining Industry.

The sales crisis which has obtained for some months past in the Ruhr continued unabated. The accumulations on the dumps amounted to 7.5 to 8 million tons. In addition, trade stocks and coal on ships amounted to about 1.5 million tons. The degree of employment in the Ruhr coal mines is practically unchanged since the commencement of the crisis. The award issued in Berlin on April 22nd by the Arbitration Committee appointed by the Reich Minister of Labour in the wages dispute was rejected by both parties. The Minister of Labour thereupon decided to declare the award as binding. In West Upper Silesia the pit coal output amounted in April to about 960,000 tons, and was thus by about 125,000 tons smaller than in the preceding month. This decline is partly due to there having been one working day less in April as compared with March and partly to the dropping of further shifts. Sales showed no improvement. The competition of British coal continued to be felt very considerably. The position on the inland coke market became worse, and no improvement can, of course, be anticipated in the coming summer months.

Iron Industry.

The negotiations in regard to the formation of an association for "A" products (semi-manufactures, railway permanent way material, and sectional iron) led to an agreement on April 23rd, so that the formation of the association may perhaps be anticipated with certainty. The negotiations in regard to the formation of a rolled wire association were continued. The preferential tariff for shipbuilding iron, which has for long been demanded, was introduced on April 20th. It provides for freight reductions in class B of 30 per cent., in class C of 33 per cent., in class D of 35 per cent. In addition, the freight rates of preferential tariff 6a for coal to the Sieg, Lahn and Dill districts were reduced by 10 per cent. on April 1st. French and Belgian competition was felt, particularly in rails, bars and tin-plates. In the Siegerland iron ore mining industry several mines have informed their employees that they are no longer able to bear the continuous working losses and will have to close down. The slight improvement on the pig iron and tin-plate market which set in at the beginning of the month was not maintained. Employment in the rolling mills was, on the whole, still satisfactory, while the foundries and machine building works were quiet. Only a few orders were received for steam boilers and iron constructions. Tinware factories and

galvanising works were compelled to restrict operations and curtail working hours. On the Upper Silesian pig iron market business continued to fall off as a result of the shortage of capital and foreign competition. Besides British iron, Czech material was also sold on the natural markets for Upper Silesian pig iron in fairly large quantities and at prices below the Upper Silesian Syndicate's prices. This competition was all the more difficult to meet as the proceeds hitherto obtainable were below the cost of production. Foreign sales possibilities were practically non-existent.

Machine Industry.

The degree of employment in the machine industry was not uniform. There is no doubt that the industry has partly recovered during the past few months, but sales varied very considerably. In general, they showed some improvement, but, on the other hand, profits diminished rather than increased. The lack of Reich railway orders was much felt in the wagon and locomotive industry. A slight recovery of business occurred in agricultural machinery. In the small iron ware industry in the Hagen and Mark districts sales fluctuated. In general, the position became worse, particularly as the increase in wages which had been made practically everywhere affected competition. In the Schmalkalden district the situation improved somewhat.

Shipbuilding Industry.

The position of this industry continued very unfavourable. No orders for new constructions were received, so that, with the gradual completion of the ships still under construction further workers and employees had to be dismissed. Though the preferential railway tariff for shipbuilding material brought some relief, prices for raw materials were still too high in comparison with the pre-war level. Unfortunately, no further progress was made in freeing the shipbuilding industry from the turnover tax.

Metal Market.

Trade declined on the metal market. The political uncertainty and strikes accentuated the general weak tone. Not until towards the end of the month did prices again advance. The world's market was quiet. Towards the end of the month copper stood more than 10 per cent. below the quotation at the beginning of the year, while tin stood at the end of the month somewhat above the level obtaining at the beginning of the month. The quotation for lead was 30 per cent. lower than at the beginning of the year. Zinc did best, being higher at the end of the month than at the beginning.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Material Improvement.

SOMETHING tangible, in the shape of increased actual orders for structural steel, has come along this week to stimulate the more hopeful spirit which I have recorded as having been manifest in Midland iron and steel and engineering circles, and the Birmingham weekly iron market, during the past three weeks. True, they are not of large dimensions, but they show a decided improvement on recent demands, and are accordingly heartily welcomed. Moreover, recent unemployment statistics suggest that more work is forthcoming in most of the Black Country towns. As the reverse is the case in the Birmingham area, some expansion of the basic industries would seem to be indicated. Merchants are agreed that inquiries are increasing and, in some cases, a marked improvement in turnover has been registered. Unfortunately, a lot of this new trade is captured by Belgians, who continue to quote prices which local makers cannot accept. There is still much instability of prices, which have not settled down after the breakdown of the price regulating arrangements.

Better Steel Business.

There has been a decided quickening in the demand for constructional steel, which has been by far the liveliest branch of the market this week. More active inquiries are developing into larger orders. Continental producers are competing strenuously for the business, offering joists and angles at prices much below those which British mills can entertain. Home quotations have fallen about half-a-crown per ton, being now round about £8 7s. 6d. for substantial orders; but £8 10s. to £8 15s. is required for the small lots with which many consumers carry on. There is no sign of the shipbuilding and railway demand rising to that level, and, pending the development of this branch, a large part of the modern steel-making plant must continue idle. Recent quotations from Belgium indicate a determination to retain the very substantial trade done with this country, for, though there is no means of checking the quantity of Belgian steel shipped from Antwerp to foreign ports to the order of British merchants, it is known to be considerable. As finished steel bars can be obtained f.o.b. at £5 15s., English steel at £8 10s. to £8 15s. has no chance of meeting this competition. The foreign material can be delivered into this country at £6 17s. 6d. to £7. The gradual decline of Belgian billets since the beginning of the year has stimulated speculation. Two inch billets have been offered for June delivery at prices below makers' current quotations, and the issue is awaited with interest. Shippers want about £5 2s. 6d. Antwerp, and the freight comes to roughly £1. For soft billets from British mills the general basis is £7, though some steel works are accepting £6 17s. 6d. The recent removal of the price restrictions on plates and other material has not done much, it would appear, to stimulate business. Ship, bridge, and tank plates command £9 5s. to £9 10s., and boiler plates £13. Staffordshire hoops are quoted £11 10s. at works.

Finished Iron Position.

The Staffordshire iron trade is decidedly slow, but the demand for marked bars is maintained, in spite of the comparatively high price of £15 per ton. Crown bars are in no better demand, the relatively low price of steel barring the way to any recovery. Though they are still quoted £12 15s., it is possible to secure supplies at £12 7s. 6d., a slight reduction on recent figures. Ironworks in the Black Country re-rolling steel have great difficulty in meeting the competition of the Continent in tube strip, bedstead material, hoops, &c. For nut and bolt iron the foreigners have further reduced their price, offering No. 3 iron at £7 to £7 2s. 6d. delivered in the Black Country, which is very much below anything that Staffordshire makers can entertain, although, on the point of quality, the local material is out of all comparison better and more reliable. The nut and bolt trade is rather quiet, but for the business available makers, by reason of their up-to-date plant, are well in the running. The bulk of the iron for the nut and bolt industry in the Black Country continues to be imported, which is not surprising in view of the substantial difference in the price of the home and foreign material.

Galvanised Sheets.

The sheet mills continue to find fairly regular employment. A passing intermission in the flow of overseas orders for galvanised sheets caused a break in prices, a certain amount of business being done at £16 5s. f.o.b. for 24-gauge. With a renewal of buying on behalf of South America and other foreign markets, the position was quickly righted, and on 'Change in Birmingham to-day—Thursday—quotations were back on the basis of £16 10s. f.o.b. The tin-plate trade has been shaken by the overthrow of the price stabilisation arrangement, and buyers are taking the measure of the new situation before committing themselves much beyond early requirements.

Pig Iron Situation.

Pig iron is in no better request, and quotations are often shaded. Much depends upon the individual circumstances of buyers and sellers. A few pig iron transactions at exceptionally low prices are reported. Some of the smelters, although placing restrictions upon output, find it impossible to prevent the accumulation of stock; this often explains the making of liberal concessions. Foundry material is slightly weaker this week, Northampton No. 3 having been sold at £3 9s. and Derbyshire £3 15s., a reduction on last week's figures in both cases of about 1s. per ton. If prices were fairly stable new business would be forthcoming, the small orders placed being invariably for urgent delivery. Whether it would be possible to squeeze another sixpence or so out of furnacemen, if there were any big orders hanging in the balance, can only be surmised, for there are no orders of any size under negotiation. The demand for forge material is small indeed, and quotations remain unaltered. Exactly what figure would be accepted for a good order it is not possible to determine.

Black Country Industrial Development.

The Black Country has been so hard hit by the slump in the iron and steel trades that it is welcome news to hear of any new industry being commenced. Practically with the cessation of hostilities Holcroft's steel foundry, Bilston, closed down, and since then the greater part of it has been idle. One portion was opened up some time ago by the Stainless Iron Company, and I now learn that a cable manufacturing company is proposing to open up the other portion. The firm is stated to have made successful experiments in producing a new metal for its deep sea cables, and the works are to be used for its manufacture. The output, which will be conveyed to London by lorry, is expected to reach upwards of 30 tons per week. Several furnaces have already been got going, and it is hoped to have the concern in full operation by July, when it is possible that there will be upwards of 40 furnaces in use for the manufacture of the metal, and between 200 and 300 workmen engaged.

Equipping Coventry Technical Institute.

Coventry is busily engaged in equipping with up-to-date machinery its Technical Institute, and the manufacturers of the city have responded liberally to the appeals made by the Mayor for machinery and equipment required for the new laboratories and workshops. Gifts to the value of approximately £4000 have already been received, and include machinery and equipments of tools to the value of £1580 from Alfred Herbert, Ltd., and machinery to the value of £1700 from the Daimler Company, Ltd.; while the Skefko Ball Bearing Company, Ltd., has offered to supply at half price all the ball bearing fittings required for the new workshops. The Coventry Education Committee has decided to spend a sum not exceeding £4000 on additional equipment, so that the Institute should be in a position materially to assist in the training of skilled workers for the Coventry industries.

Conversion of Canals into Roads.

During a discussion on the national road transport scheme to convert canals into roads, which took place at a recent meeting of the Wolverhampton Chamber of Commerce, it was prophesied by Mr. T. W Simpson that in fifty years' time there would not be a heavy industry left in Wolverhampton except those which got their raw material on the spot. "If we don't get to the ports the ports must come to us," is Mr. Simpson's contention. Mr. Felix J. Blakemore said that the scheme would not involve a very heavy expense, and that it would solve the question of heavy road transport and congestion. The canals were largely derelict, and to reconstruct them would entail enormous expenditure.

New Midland Road.

It is proposed to construct a new road from Burton to Branstone, at a cost of £50,000, and, following a meeting of representatives of the Staffordshire County Council and the Burton-on-Trent Corporation, further consideration of the matter has been adjourned in order to ascertain what grants the Ministry of Transport is prepared to make.

Unemployment.

During last month the returns issued by the Ministry of Labour showing the number unemployed in the Midlands have recorded increases and decreases in alternate weeks. The total of 134,140 for the current period is 764 lower than it was in the previous week, and is made up of 95,425 men, 2443 boys, 32,572 women, 3700 girls. There are now unemployed in the Birmingham area 26,896; Coventry, 1292; Bilston, 3522; Cradley Heath, 4402; Derby, 1494; Dudley, 3556; Leamington and Warwick, 363; Leicester, 3683; Northampton, 1755; Nottingham, 9547; Oldbury, 1556, Peterborough, 501; Redditch, 964; Smethwick, 4087; Stoke-on-Trent area, 13,862; Stourbridge and Brierley Hill, 3467; Tipton, 2166; Walsall, 5538; West Bromwich, 2837; Wolverhampton, 4836; Worcester, 1523; and Wednesbury, 2457.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THE general condition of the iron and metal markets is certainly very dull, but it does not appear that things are any worse than they were. Of course, one cannot deny that business in the Lancashire district is very much restricted, but that has been the case for a long time, and no one looks for any serious revival now for at least three or four months. There was at first some mutual congratulation when it was announced that the big shipbuilding contract for the new Blue Star Line ships had been placed in this country; but afterwards when it became known that the contract was not placed on competitive terms, one did not feel so satisfied. If buyers of ships have to pay 10 per cent. out of their own pockets in order to place contracts in Great Britain, one cannot see that there is much upon which to offer any congratulations; and besides this it is obvious that the steel works which supply the plates and angles will be running a profitless business.

Metals.

The markets here for the non-ferrous metals do not show any very decided tendency one way or the other. A small business is being done in tin, and on the whole the prices here have been a little steadier than they were, but no one seems to have any opinion as to the probable course of the market. There has been some falling off in the demand from America, and if this develops the market here will undoubtedly feel it, for the European demand will not sustain the present prices. It is, however, by no means clear that the present quietness in America is more than a temporary phase. The canning industry and the motor industry are both very active, and can still absorb a large quantity of metal. There is some increase in the output of F.M.S. tin, but it is not enough to affect the market if the American demand is kept up; but if that fails then the increase of the Eastern supply might easily tell on the price. Copper remains a quiet market, with the price keeping near to £60 for standard. It is perhaps a little unreasonable to look for lower prices, and yet the recent rise and fall seem to have destroyed confidence. It seems to be generally admitted that the American consumption of copper is decreasing, and the question arises whether the reduction of the output of the Anaconda Company is sufficient. That policy, in the absence of some agreement with the other producers, is, of course, liable to lead to increases by all those works which can get a good profit at present prices, and moderate as the prices are, there are still many copper producers who can work quite satisfactorily with them. The manufacturers of brass and copper, although they advanced the prices promptly when standard rose to £63, have been rather slow in putting them back again. They are now beginning to do so; but if a rise of £3 or £4 leads immediately to a corresponding rise in sheets and tubes, then a fall of £3 or £4 should lead immediately to a similar reduction. There would, of course, be something to be said for delaying the change in each case Lead is a quiet and fairly steady market, but there is not any great confidence in it. Spelter keeps steady, and the recent changes are insignificant.

Pig Iron.

There is only a small retail demand on the Manchester Exchange to-day for foundry iron, and the prices seem to be rather easy. Some sellers of Derbyshire No. 3 still ask 83s. 6d. per ton delivered, but as a rule 82s. 6d. in Manchester is now accepted without any question. One cannot say, however, that the consumer is satisfied about this price, and apparently no one is disposed to buy more than is wanted for current requirements. The idea amongst foundrymen is that the price in Manchester will eventually be 80s., but whether, if and when that price arrives, consumers will be ready to buy for future delivery, is perhaps doubtful. Northamptonshire foundry iron is still at 70s. on trucks at the furnaces, and although it does not come here, it competes with Derbyshire in the Midlands. On the other hand, Derbyshire makers have a better opportunity of selling in the North of Lancashire now that the truck price of Cleveland iron is 1s. 6d. to 2s. per ton more than the furnace price. There is a moderate demand here for East Coast hematite iron, and as it can be bought locally at from 7s. to 9s. per ton less than Scotch, it is a cheap material for the founders who have become accustomed to its use. Scotch iron is still quoted at 101s. 6d. to 102s. 6d. delivered, and is too dear in Manchester for ordinary use. There is a little Lincolnshire iron here at about 83s. 6d. per ton, but we do not hear that the two furnaces recently started are yet offering any foundry iron.

Finished Material.

There is no change in the position of the Lancashire finished iron trade, and the price of bar iron remains far too much above that of the continental makes. Rumours of an application for protection under the Safeguarding Act have not yet received definite confirmation. The finished steel market here is again reported very dull and depressed. Merchants do not get much business, and what there is has to be taken at low figures. The nominal prices for finished steel are unchanged, viz., £8 10s. for sections and £9 5s. for plates, but there are concessions to be obtained. One does not hear of any change in the general position, but, of course, it is known that competition is severe, and hence it is guessed that prices must be irregular now that there is no agreement amongst the makers to hold them up.

Scrap.

Dealers in scrap here give one the impression that the market is considerably worse than it was, and that the opportunities of selling are very few. For heavy steel-melting scrap there is said to be no demand whatever from Sheffield; and although some might be sold in Wales the rate of carriage would bring the price down to about 50s. per ton on trucks in Lancashire. Dealers here have been paying 55s. per ton of late, and do not like to contemplate such a price. For heavy wrought scrap there is still a moderate demand at 80s. per ton delivered; but cast scrap seems again to be on the move downwards. One hears of 77s. 6d. being accepted by dealers for good scrap, and even textile machinery scrap has been mentioned at 80s. per ton. The buyers seem to be able to do as they like, as there are weak sellers about who are anxious to get orders.

BARROW-IN-FURNESS.

Hematite.

The condition of the hematite pig iron trade in the north-west district remains unaltered, and makers, as a result of the demand being so light, are compelled to put iron into stock. There is a certain amount of iron going into stock awaiting customers' instructions, but the quantity is not heavy, for there is little tendency to place orders for forward delivery. Business with Scotch buyers is thin, and that with the Midlands leaves room for much improvement. Buyers' requirements are not heavy, and the prospect of a bigger demand does not seem to be near by the present signs. Continental trade is dull, and that with America is moderate. Special qualities are in slow demand at present. The charcoal furnace at Backbarrow is kept supplied with orders.

Iron Ore.

The iron ore trade is a reflection of the iron trade with the exception that there is not much being stocked. Ore is being raised in just sufficient amount to supply demands which are local to a very great extent. Business with Scotland has shrunk. Foriegn ore is arriving regularly, but is not overtaking the consumption to any great extent. Ore from Kirkenes in Norway continues to arrive.

Steel.

The steel trade is not very brisk, and orders are constantly required to keep the rail and sleeper mills engaged. The Barrow rail mills are still running, and the Cumberland sleeper mills have had some work, but the orders are not sufficient to guarantee regular running. The hoop and small section mills at Barrow are better circumstanced.

SHEFFIELD.

(From our own Correspondent.)

Heavy Trades Quiet.

A SLIGHT improvement in the heavy steel trades has to be recorded, but it is due more to the anticipation of another lengthy stoppage at Whitsuntide than to any real brightening of business. Everyone, however, is hoping that there will not be a repetition of the Easter experience, when there was a long holiday followed by an exceptionally quiet period. Indeed, some of the men who were suspended at that time have only just been restarted. The basic open-hearth steel furnaces are experiencing the greatest difficulty in maintaining their output, even at its present low level, and unless orders increase in both number and volume, a further curtailment of production would seem to be inevitable. Fortunately, acid steel is in a much more healthy state, and those who some time ago converted their furnaces from basic are now reaping the benefit of their foresight. There is no improvement in the call for pig iron, buyers being content, in spite of the easier prices ruling, to purchase only for their immediate requirements. The amount of business being done in bar iron is almost negligible, and producers are complaining of the severity of continental competition. As a result of this inactivity in iron and steel, transactions in the scrap market are scarce, but despite the lack of business, holders are disinclined to offer anything but small concessions.

Engineering Departments.

Heavy engineering shops are only partially employed, though every avenue of possible business is being diligently explored. Shipbuilding and armament work are scarce, and the big firms owning enormous plants are finding it very difficult to quote reasonable, and yet profitable terms, and at the same time maintain a lot of idle plant. Railway orders continue to arrive in consistent batches. The London and North-Eastern and the Great Western railway companies have recently placed large orders for tires, axles, springs and stores with British firms, and of those orders Sheffield will get a share. Low prices, however, have had to be accepted because of the figures offered by makers in Germany, France and Belgium, which were in one case £10 and in the other £6 per ton below the British quotations. The manufacture of motor car steel is another line in which considerable activity prevails, the Sheffield product being greatly in demand because of its reliability and high quality. In the lighter steel trades, conditions are variable, but some firms are able to maintain fairly regular working. A large batch of orders for files and tools has been received from Russia, and there are many inquiries for similar goods from the same source. It is gratifying to record steady progress in overseas business in certain lines. During the last four months exports of files, rasps, saws and carpenters' and joiners' tools have increased from six millions last year to eight and a-half millions. Although the first buying season is almost over, a brisk trade is still being done in all classes of steel garden and farm tools and implements.

Valuable Colliery Contract.

An order for a hydraulic decking installation for a South Yorkshire colliery has been secured by the Brightside Foundry and Engineering Company, Sheffield. This plant, the cost of which runs well into five figures, will be one of the largest in the country, if not in the world. With the exception of the electric motors which will be used to operate the plant, the whole of the equipment will be manufactured at this company's works in Sheffield, and employment for several months will be found for a considerable number of men. This is a particularly welcome piece of news when so many collieries are being forced to close down because of the prolonged spell of bad trade, and it tends to show that colliery proprietors and engineers are fully alive to the necessity for installing modern plant and thus making more economic production possible.

Cutlery and Plate.

The returns of cutlery exported last month show increases over the March figures in knives, but decreases in razors and scissors, though the first-named is doing the largest volume of trade. This is satisfactory so far as it goes, but the fact remains that the cutlery trade is far from flourishing. The home market is depressed, and though the output of cheap stainless knives is considerable, severe competition has cut profits to a fine margin. A slight revival in activity is noticeable in silver and electro-plate ware, but these departments for the most part are unable to maintain regular or full-time working. Although there have been a lot of rumours about public taste changing in favour of the better grade articles, the chief demand is still for cheapness, and the higher-priced goods are difficult to sell.

New Coal Seam.

Last week I noted the success which has attended the sinking operations at the new Firbeck Colliery. Following this announcement comes the news of another triumph for the Markham group of collieries. After sinking operations of about eighteen months, the black shale seam, between 3ft. and 4ft. thick, has been struck at the Pebley shaft, near Barlborough. The pit is owned by the Staveley Coal and Iron Company, and it will prolong the life of the old Barlborough Top Hard Pit, with which the new shaft will be directly connected. Some weeks ago a "fault," which caused considerable disappointment, was reached, but continued operations have now revealed the true seam of big soft coal. Full engineering equipment and plant is being laid down, and the pit-head gear is already erected. It will not, however, be necessary to lay out extensive sidings or screening plant at the new Pebley shaft, as it is proposed to bring the coal up the old Barlborough shaft.

Growth of Colliery Town.

As a result of the developments at Thorne Colliery, it is anticipated that 1000 men will be employed next year and twice that number the following year. The local authority is now engaged in preparing to accommodate this increase in population, and has prepared a sewerage and sewage disposal scheme, which will cost £32,500. Application for power to borrow that amount has been made to the Ministry of Health. The Barnsley seam in No. 1 shaft was reached nearly a year ago, and it is expected to reach it in No. 2 shaft about October. The Kent thick seam should be reached by August.

Modern Bridge Building.

The opening of the new bridge over the river Derwent at Baslow is the first item in an important programme undertaken by the Derbyshire County Council. This bridge, towards the cost of which the Ministry of Transport has granted 65 per cent., the land being given by the Duke of Devonshire, has been constructed to the designs of the County Surveyor, Mr. J. W. Horton, M. Inst. C.E. It is an excellent example of modern bridge construction. The old bridge, built three centuries ago, is 250 yards away, and it has not been interfered with. It has a "camel back" of 14½ft., and dangerous right-angled turns. The new bridge provides a level road 40ft. wide with sweeping approaches. Lockhill Bridge at Killamarsh, and Eggington Bridge below Derby, will be completed shortly, and the County Council is hoping before long to tackle the difficult problem at Rowsley.

NORTH OF ENGLAND.

(From our own Correspondent.)

Shipyard Orders.

THE outstanding feature in trade circles in the North of England this week has been the placing of a number of orders in the shipbuilding industry. Perhaps in no place on Tyneside has the shipbuilding depression been so seriously felt as at Jarrow. Unemployment has been particularly rife there, and the news that the Blue Star Line has placed an order for two of its new fleet of eight express steamers of large refrigerator capacity, to bring its Argentine to London chilled meat service up to date, with the Jarrow firm of Messrs. Palmer's, has been received with great satisfaction. A contract for three medium-sized cargo vessels has been secured by the Smith Dock Company from British owners. The vessels, which will be constructed at the firm's shipyard on the Tees at South Bank, will take some seven or eight months to build, and will find employment for a large number of men over that period. The order has been secured in face of keen competition, although it is believed that the owners were unwilling to place it elsewhere than in the hands of British builders. Sir W. G. Armstrong, Whitworth and Co., Ltd., have secured a contract from the Mersey Docks and Harbour Board for the supply and erection of three pairs of steel gates for the river entrance of the Alfred Dock at Birkenhead, which has a width of 80ft. The work is to be completed within a period of twenty-two months.

Cleveland Iron Trade.

The position in the Cleveland pig iron trade is still very discouraging. There has been some slight improvement this week in the home section of the trade, several of the Scottish works having bought more freely, but the total volume of business is very small, and has had little effect on the general industrial position. The export trade is almost lifeless. Continental prices seem to be falling even more rapidly than British, and the fact that good foundry iron is being offered at 70s. per ton f.o.b. Antwerp is very disconcerting to Cleveland makers. Of course, that is a figure with which Cleveland producers find it quite impossible to compete, and as a consequence the export business has fallen to very small proportions. Certainly Cleveland prices are so low that they cannot fall much further, and the disposition of makers is to blow out their furnaces rather than make any further sacrifices. The general market quotation for No. 3 G.M.B. Cleveland pig iron is 70s., No. 1 being steady at 81s., No. 4 foundry 75s., and No. 4 forge 74s. per ton.

Hematite Pig Iron.

The demand for hematite pig iron shows no appreciable improvement. The Consett Iron Company has now entered into competition in the foundry iron market, one of the five hematite furnaces having been transferred to Cleveland iron. This reduces the number of furnaces producing hematite pig iron to nine, yet, even so, the market is weak, and a further drop of 6d. per ton brings the nominal price to 80s. 6d. per ton for mixed numbers and 81s. for No. 1. No doubt a substantial order could be placed at less.

Ironmaking Materials.

The prospects in the foreign ore trade are poor. Freights are extremely low, as little as 6s. per ton having been paid from Algiers, yet consumers cannot be induced to buy or even increase deliveries, and best Rubio ore remains purely nominal at 22s. per ton, c.i.f. Tees. The stoppage of so many coke ovens has rather strengthened the position of producers, who are now inclined to hold out for 22s. 6d. per ton for good medium furnace coke delivered at the works.

Manufactured Iron and Steel.

There is little new to report in the manufactured iron and steel trade, though the placing of a few more shipbuilding orders on the North-East Coast has aroused hopes of better business in shipbuilding material. Meanwhile the local plant is moderately well employed, but only at cut prices, which leave little margin of profit.

The Coal Trade.

There is little variation in the trend of the Northern coal trade. The position generally is steady, due, it is stated, to the hope that some of the inquiries in circulation from abroad will be placed in this district. There has been another little spurt for prompt supplies, but it quickly died away. Chief interest is centred in the inquiry from the Swedish State Railways for 200,000 tons of British and German coals, and it is confidently anticipated that a good share at least will be secured in this district. Most of the collieries producing the best grades of coal are fairly well booked until the end of the month, and there is rather more disposition to negotiate for June. The requirements are not large, but, in view of the quiet period experienced, the promise of any little improvement is welcomed. Buyers, however, are not likely to contract far ahead until they know what is to be the outcome of the expiration of the national agreement in the coal mining industry at the end of July. Foreign buyers are in no way concerned about the talk of a national coal strike in this country, as they have now so many other sources of supply to draw upon, and are in a very greatly different position for that reason than they were when the pits stopped in 1921. Some of the collieries in Northumberland and Durham are still endeavouring to make local arrangements for a resumption of operations, and in one case a reduction of 12½ per cent. has been accepted by the men. This will permit of 1000 men and boys getting to work next week. Other collieries are still issuing notices. The demand for best steam coals continues on a moderate scale, but collieries are well supplied with orders, and hold for recent prices for prompt, while for June speculators can only secure fractional discounts. All descriptions of gas coal are freely offered, and prices are inclined to ease. Durham coking unscreened coals are in slow demand, and abundant at 16s. 6d. to 16s. 9d. per ton. The market for all qualities of coke remains lifeless, and stocks are abundant, although makers are limiting production as far as possible.

SCOTLAND.

(From our own Correspondent.)

Trade Problems.

THE difficulties in the way of trade progress are still manifold, and conditions generally remain dull and depressing. The purchasing power of home consumers is evidently very limited, while the prices obtainable for export in competition with foreign goods are said to be

unremunerative. Decontrol of prices in the steel trade has certainly led to keen local competition, but it is questionable if there has been much extra business brought out by the cheaper prices obtainable. In practically all trades, allied to steel, iron, and coal, the production has shrunk to low levels, and still remains wholly adequate to all demands. Oncosts continue on a comparatively high level, consequently unless some early change is evident, the process of curtailing outputs must go on. The situation then is an extremely difficult one for many undertakings, and the expedient of closing down entirely until better times is an ever present contingency. The announcement that one large shipping company has placed, or is to place, orders for a number of liners with British builders in face of cheaper foreign tenders, contains a measure of satisfaction, and may help to alleviate unemployment in several districts, and it would be fortunate at this time if other concerns could afford to follow suit. So long as work can be so cheaply executed abroad, the relief of the unemployment consequent on the failure of local producers to obtain remunerative contracts, must be a problem. Further, markets formerly favourable to Scottish products are apparently lost perhaps temporarily. The drop in coal shipments is tremendous, if not altogether alarming, when it is seen that home demands are wholly inadequate to make good even a small proportion of the loss. Steel and iron are not much better off, and markets generally present a more dead than alive appearance.

Pig Iron.

There is practically nothing of a fresh nature in the pig iron market. The total consumption remains far below normal and weakness is evident. Makers cannot clear stocks, and prices are falling with comparative regularity. There seems little doubt that business could be done below the prices given as current quotations, if a fair order was in prospect.

Steel and Iron.

Dulness and scarcity of tonnage characterise proceedings in the steel and iron markets. Steel plates and sections are still particularly slow to move, the former, compared with normal times, being almost negligible. Steel sheets, too, are not now so well placed, buying being restricted to small parcels for immediate use. Export inquiry is said to be a shade better, but the tonnage involved is disappointing. Bar iron makers are said to be interested in new work recently placed with wagon builders, but some time must elapse before the ironworks can reap any benefit. For any small export lines secured, prices have to be severely cut. The re-rolled steel department is almost as badly off, even with the quotation somewhere between £8 and £8 10s. per ton home or export. Generally speaking, forward buying is almost unknown at present.

Coal.

The scarcity of new business becomes more evident every week that passes, and the depression in the trade is most acute. The closing of pits until busier times is still a fairly regular occurrence, but even with the output curtailed to an unusual degree, the production is still more than adequate for all demands. The Baltic trade is especially disappointing, and with Belgian and Italian consumers curtailing their orders, it is little wonder that shippers with a prompt order to place can receive very favourable terms. All descriptions of fuel are alike weak. Aggregate shipments amounted to 219,220 tons, against 208,891 tons in the preceding week and 256,391 tons in the same week last year. The home market is unsatisfactory, industrial demands being still exceptionally low, while other sources of consumption are at a low level owing to the season of the year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE best that can be said about the steam coal trade is that for the time being it is well maintained. Hopes are entertained that very shortly some definite news will be forthcoming that will form a real guide as to the prospects of an agreement being come to between the employers and the workmen's leaders regarding the revision of the wages agreement. Enlightenment on this point would be very welcome, inasmuch as apart from this feature it cannot be said that the outlook shows any promise. The indications are, indeed, that the present unsatisfactory conditions may drag on to the end of the year, especially as trade during the summer months is usually quieter than it is in the early part of the year and in the autumn. During the past few weeks shipments have certainly been rather more active, and in some instances coal prices have advanced 3d. per ton, but the improvement all round has not been on a material scale. The docks are moderately busy, owing to the fact that the tonnage available is rather larger in carrying capacity than usual; but at the same time the foreign demand is comparatively quiet and featureless, and evidence is forthcoming almost daily of the severe competition of German coals. One reason for shipments being slightly more active than they have been of late is doubtlessly that the Whitsuntide holidays during the first week of June will dislocate arrangements to some extent, and cause a reduction in output, with the result that shippers deem it advisable to get supplies away earlier as far as possible. At the moment shipments to Spain and Portugal are decidedly better. It is understood, however, that in regard to a recent inquiry for 6000 tons patent fuel for account of Spanish railways, the business has not come to a satisfactory conclusion, so far as Welsh manufacturers are concerned, as the contract has been placed for Spanish-made fuel. The Portuguese Railways are in the market for 13,000 tons, consisting of about equal quantities of best large and best smalls, for delivery during June, and another Spanish inquiry is for 10,000 tons of patent fuel for shipment in three cargoes of 2000, 3000 and 5000 tons, to be delivered over this and next month.

Coalfield Items.

The majority of the leading colliery undertakings are working fairly regularly, but in other directions the position leaves much to be desired. Hopes had been entertained that an arrangement would have been come to which would have enabled work to be resumed at the Blaenavon collieries. These pits have been idle for about two months, as the result of trade depression, and about 2500 men have been unemployed. Efforts had been made to devise schemes for a resumption, and certain terms had been offered by the owners, but on Monday night they were rejected by the men, so that the collieries will remain idle. Notices were recently served on the miners at the Ynysfaio Colliery, but have since been withdrawn, except as regards a large portion of the 7ft. and Gorllwyn seams, in which districts work will be stopped. About 300 men out of about 1400 will thus be rendered idle. All the workmen and officials engaged at the Coed-Ely collieries of the Welsh Steam Navigation Coal Company, numbering about 1700, were given fourteen days' notices on Monday to terminate their contracts.

Coal Shipping Charges.

The official report issued last week by the Joint Sub-committee appointed by the Mining Association and the Miners' Federation referred to the heavy burden of the cost of shipment of coal at South Wales ports, and stated in particular that the charges payable by the collieries to the railway company for the shipment of coal at Cardiff and other South Wales ports showed an increase of 213 per cent. over the 1913 figure. Mr. E. Lowther, the chief docks manager of the Great Western Railway Company, in a communication, has pointed out that this statement is likely to be misunderstood by many people, and he shows that, taking the average railway rate, the charge for shipping coal, the charge for weighing and wharfage in pre-war times came to 1s. 4½d., as against the present figure of 2s. 6½d., the increase of 1s. 2½d. representing a percentage increase of 87. In reply to this statement, Mr. Finlay Gibson, the secretary of the South Wales Coalowners' Association, now states that the Joint Sub-committee examined separately the different items constituting the whole of the charges from pit to port, and reference in the joint report is clearly and specifically made to the charge for the shipment of coal, which charge refers solely to the tipping and weighing of coal at the docks. It is this isolated item that shows the increase of 213 per cent., viz., from 2½d. per ton pre-war to 7¾d. per ton at present. He maintains that the increase in tipping and weighing is altogether out of proportion to the increase in other charges. Most of the other dock charges in South Wales, he says, are to-day subject to an increase of 60 per cent. over the pre-war level. If the pre-war tipping and weighing charge of 2½d. had been increased by that percentage, the cost would have been 3¾d. per ton instead of 7¾d. The actual charge is 3¾d. greater, and on 36 million tons of coal exported from the South Wales docks that extra 3¾d. represents approximately a sum of £550,000. The coal trade of this district, therefore, is penalised to this extent as compared with other exporting districts.

Ship Repairs.

The contract for carrying out the repairs on the s.s. Pilton, which was recently refloated after stranding on the rocky foreshore off Sully, has been secured by the Barry Graving Dock and Engineering Company, which is a subsidiary undertaking of the Cardiff Channel Dry Docks and Pontoon Company. The work will take about three weeks to execute, and will provide much welcome employment for a considerable number of boilermakers and other workmen. Apart from internal work, a large number of bottom plates will have to be dealt with.

Iron and Steel Trade.

It is understood that as from Tuesday the price of tin-plate bars at Swansea was reduced from £7 to £6 15s. per ton. Notices were posted during last week-end at the Ashburnham Tin-plate Works, Burry Port, that the works would close down as from Saturday for a period, but that the finishing department would continue to work until stocks were cleared. A work-sharing scheme which had been under consideration by tin-plate workmen at Gorseinon has fallen through, it being understood that the tin-platers in the district who are employed are arranging to make a voluntary levy towards the assistance of those who are idle. The purpose of the scheme was to absorb the men out of work as the result of the closing of old works.

Large Tin-plate Order.

It is reported that Richard Thomas and Co., Ltd., have obtained a large order for oil plates for delivery during July, August and September. The order is for 500,000 boxes, and the price accepted is stated to be 19s. 9d. f.o.b. basis. This is below the current market quotation, thus indicating the keen competition prevailing now that the stabilisation of prices scheme has terminated.

Rumoured Dry Docks Combine.

Negotiations are reported to be proceeding for the amalgamation with the Channel Dry Docks and Pontoon Company, Ltd., of the undertaking of Messrs. Elliot and Jeffery, the old established ship-repairers, who own the Windsor Slipway at Penarth, and have works at Cardiff and Barry. If the negotiations are successful, it is understood Mr. John Elliot, partner in Messrs. Elliot and Jeffery, will become managing director of the Channel Combine.

Current Business.

New business in steam coal continues to be very restricted, and is confined to occasional cargoes for fairly early shipment, for which, however, the prices offered are so low as to leave little or no margin of profit, more especially as rates of freight, except for the short trades, have a firmer tendency. With homeward business so bad, shipowners are experiencing increased difficulty in running tonnage, and there is the prospect of additional steamers being laid up if the conditions do not improve. This is an important factor from the point of view of the exporter of coals who has to take the risk of freights. Best Admiralty large and seconds continue to be fairly well-stemmed, and the same is the case with some of the leading Monmouthshire qualities, but as regards other descriptions orders are wanted. Smalls keep steady, and there is no alteration of note with respect to patent fuel and coke. Anthracite coals maintain a good tone, except that duff coals are still easy and in fairly plentiful supply.

CATALOGUES.

THE STAVELEY COAL AND IRON COMPANY, Ltd., Chesterfield.—Stock list of cast iron pipes.

JONES AND SHIPMAN, Ltd., Leicester.—List No. 17 of valve re-seating equipment for motor engines.

MANLOVE, ALLIOTT AND CO., Ltd., Nottingham.—Monthly wall calendar illustrating a laundry hydro-extractor.

THE JOSEPH DIXON CRUCIBLE COMPANY, 22, Duke-street, S.E. 1.—Descriptive booklet of Dixon's silica-graphite paint.

THE VAUGHAN CRANE COMPANY, Limited, Openshaw, Manchester.—Folder illustrating overhead electric travelling cranes.

R. W. CRABTREE AND SONS, Ltd., 7, Farringdon-road, London.—Brochure on the "Crabtree" rotary high-speed printing press.

SZERELMEY, Ld., 273–277, Rotherhithe New-road, S.E. 16.—Booklet entitled "The Cause and Cure of Damp and Decay in Masonry."

THE VICKERS-SPEARING BOILER COMPANY, Ltd., 20, Kingsway, W.C. 2.—Revised edition of the catalogue entitled "Chain Grate Stokers."

THE WESTMINSTER TOOL AND ELECTRIC COMPANY, Ltd., 116, Putney Bridge-road, S.W. 15.—List giving details regarding British-made flexible shaft drives.

THE ENGLISH ELECTRIC COMPANY, Ltd., Queen's House, Kingsway, W.C 2.—Price list 2010, dealing with air break circuit breakers, classes S K A and S K B.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, Ltd., 36–38, Kingsway, W.C. 2.—Brochure of special charging machinery for steel reheating furnaces.

THE COAL CONVEYORS COMPANY, 2, Park-grove, Cardiff.—Catalogue illustrating and describing the principal products of the company for the conveyance of coal.

THE CEMENT MARKETING COMPANY, Ltd., Portland House, Tothill-street, S.W. 1.—Report on the rapid-hardening "Ferrocrete" Portland cement, by Dr. Oscar Faber.

HUNT AND MITTON, Ltd., Oozells-street North, Birmingham.—Bound catalogue of manufactures, including boiler mountings, fire-extinguishing appliances, hydraulic fittings, &c.

THE SPERRY GYROSCOPE COMPANY, Ltd., 15, Victoria-street, S.W. 1.—Pamphlet No. 194, entitled "The Fundamental Principles of the Gyroscope and the Gyro-compass."

HEPBURN CONVEYOR COMPANY, Ld., Rosa Works, Wakefield.—"Conveyor Transporter and General Elevating Appliance, Catalogue" and a "Power Transmission Appliance Catalogue."

HOLMAN BROTHERS, Ld., Camborne.—List No. 60/25, dealing with pneumatic chipping, caulking and riveting hammers, and a leaflet describing the "Holman" automatic air line lubricator.

THE DOWSON AND MASON GAS PLANT COMPANY, Ltd., Levenshulme, Manchester.—Booklet, entitled "Oil and Petrol Handling Simplified," showing various types of oil and petrol pumps, cabinets, tanks, &c.

EDGAR ALLEN AND CO., Ltd., Imperial Steel Works, Sheffield. Catalogue C, second edition, entitled "The Edgar Allen Steel Foundry Book," and a pamphlet entitled "The Permeability of Imperial Dynamo-magnet Steel Castings."—Also pamphlet, entitled "Imperial Stainless Steel and Iron," and the sixth edition of "Railway Switches and Crossings."

BRITISH ASSOCIATION.—The annual meeting of the British Association for the Advancement of Science will be held at Southampton from Wednesday, August 26th, to Wednesday, September 2nd next, under the presidency of Professor Horace Lamb, F.R.S. The sectional presidents are as follows:—A (Mathematics and Physics) Dr. G. C. Simpson, F.R.S.; B (Chemistry) Professor C. H. Desch, F.R.S.; C (Geology) Professor W. A. Parks; D (Zoology) C. Tate Regan, F.R.S.; E (Geography) A. R. Hinks, F.R.S.; F (Economic Science and Statistics) Miss Lynda Grier; G (Engineering) Sir A. Denny; H (Anthropology) Dr. T. Ashby; I (Physiology) Professor A. V. Hill, F.R.S.; J (Psychology) Professor C. Spearman, F.R.S.; K (Botany) Professor J. Lloyd Williams; L (Educational Science) Dr. W. W. Vaughan; and M (Agriculture) Dr. J. B. Orr.

THE INSTITUTION OF CIVIL ENGINEERS.—At the annual general meeting of the Institution of Civil Engineers, held on Tuesday evening, May 12th, the result of the ballot for the election of Council was declared as follows:—President, Sir William Henry Ellis; vice-presidents, Mr. Frederick Palmer, Sir Archibald Denny, Mr. E. F. C. Trench, Captain Riall Sankey. Other members of Council:—Mr. R. D. Thain Alexander, Mr. H. N. Allott, Mr. A. A. Biggs, Sir Dugald Clerk, Colonel E. B. Crompton, Mr. H. A. Cutler, Professor W. E. Dalby, Sir Alexander Gibb, Mr. W. W. Grierson, Sir Robert Hadfield, Sir Brodie Henderson, Mr. E. P. Hill, Mr. G. W. Humphreys, Sir Cyril Kirkpatrick, Sir Murdoch MacDonald, Mr. J. P. Maxwell, Sir Henry Maybury, Sir John Monash, Mr. G. T. Nicholson, Sir Richard Redmayne, Sir Hugh Reid, Sir John Snell, Mr. W. A. P. Tait, Mr. H. H. Vaughan, Mr. J. D. Watson, Sir Alfred Yarrow. This Council will take office on the first Tuesday in November, 1925.

LOUGHBOROUGH COLLEGE, ANNUAL PRESENTATION DAY.—Lord Emmott visited Loughborough College on Saturday, the 16th inst., and distributed diplomas at the annual presentation day ceremony. Mr. B. B. Barrow, the chairman of the Board of Governors, in opening the proceedings, referred to the serious loss the College had sustained through the death of the Duke of Rutland, the College Visitor, and of the late chairman of the Board of Governors, Alderman A. A. Bumpus. In his report, Dr. H. Schofield, the principal, referred to the extraordinary success of the educational work in Loughborough. Commencing in 1918 with an enrolment of seven full-time degree and diploma students, the present enrolment of the College now showed an attendance of 162. In a brief talk to the students, Lord Emmott denounced idleness. "The men who make the world go round do not stick to eight hours," he said. "You will never make life a success if you get the notion of a six-hours' day. The greatest curse of the world to-day is idleness, either enforced or voluntary, leading to boredom and *ennui*. The greatest blessing is to have work in which your soul delights, failing that, have for your leisure an occupation you really love."

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	20/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 10 0	—
No. 1 Foundry	4 8 0	—
No. 3 Foundry	4 6 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 0 6	4 0 6
No. 1	4 1 0	4 1 0
Cleveland—		
No. 1	4 1 0	4 1 0
Silicious Iron	4 1 0	4 1 0
No. 3 G.M.B.	3 16 0	3 16 6
No. 4 Foundry	3 15 0	3 15 0
No. 4 Forge	3 14 0	3 14 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 9 0 to 3 10 0	
,, Forge	3 6 0 to 3 7 0	
(3) Derbyshire—		
No. 3 Foundry	3 15 0	—
Forge	3 10 0 to 3 12 0	
(3) Lincolnshire—		
No. 3 Foundry	4 0 0	—
No. 4 Forge	3 15 0	—
Basic	3 15 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 13 0 (a); 4 16 0 (b); 5 1 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 12 6	—
Best ,,	—	—
N.E. Coast—		
Common Bars	11 12 6	—
Lancs.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 10 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 12 6 to 12 15 0	
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 12 6 to 11 15 0	
Gas Tube Strip	13 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	12 10 0	—
Ship Plates, ¾in. and up	8 17 6	—
Sections	8 7 6	—
Steel Sheets, under 3/16in. to ¾in.	10 5 0 to 10 10 0	
Sheets (Gal. Cor. 24 B.G.)	—	17 10 0

STEEL (*continued*).

N.E. Coast—	Home. £ s. d.	Export. £ s. d.
Ship Plates	8 15 0	—
Angles	8 7 6	—
Boiler Plates	13 0 0	—
Joists	8 7 6	—
Heavy Rails	8 15 0	—
Fish-plates	12 15 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 15 0†	—
Light ,,	9 0 0 to 9 5 0	
Billets	8 0 0 to 11 0 0†	
Manchester—		
Bars (Round)	9 0 0 to 10 0 0	
,, (others)	8 15 0 to 9 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 5 0	—
,, (Lancs. Boiler)	12 10 0	—
Sheffield—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
Midlands—		
Small Rolled Bars	8 15 0 to 9 15 0	
Billets and Sheet-bars	6 17 6 to 7 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	8 7 6 to 8 15 0	
Joists	8 7 6 to 8 15 6	
Tees	9 10 0 to 9 15 0	
Bridge and Tank Plates	9 5 0 to 9 10 0	
Boiler Plates	13 0 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	20/3 to 20/9
Block Tin (cash)	245 0 0
,, (three months)	247 0 0
Copper (cash)	60 5 0
,, (three months)	61 2 6
Spanish Lead (cash)	32 2 6
,, (three months)	32 2 6
Spelter (cash)	33 17 6
,, (three months)	33 7 6
Manchester—	
Copper, Best Selected Ingots	63 10 0
,, Electrolytic	64 10 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis price)	0 0 11½
,, Condenser	0 1 2
Lead, English	34 15 0
,, Foreign	33 10 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 5 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£43 0 0	15/6
,, ,, 1 p.c. ,,	£52 0 0	17/-
,, ,, 0.70 p.c. carbon	£57 10 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 15 0	scale 5/- per unit
,, ,, 75 p.c.	£22 10 0	scale 6/- per unit
,, Vanadium	17/- per lb	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/- per lb	
Nickel (per ton)	£175	
Cobalt	10/3 per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	15/-
,, ,, Ell	15/6
,, ,, Splint	16/- to 18/9
,, ,, Trebles	14/3
,, ,, Doubles	13/3
,, ,, Singles	12/6
Ayrshire—	
(f.o.b. Ports)—Steam	15/-
,, ,, Splints	16/-
,, ,, Trebles	14/3
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	13/9 to 15/9
Screened Navigation	21/6
Trebles	15/- to 15/9
Doubles	12/6
Singles	12/6
Lothians—	
(f.o.b. Leith)—Best Steam	15/9
Secondary Steam	15/-
Trebles	15/10½
Doubles	13/3
Singles	13/-

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	27/-
Household	45/- to 58/4
Coke	28/-
Northumberland—	
Best Steams	17/3 to 17/6
Second Steams	16/6
Steam Smalls	11/- to 11/6
Unscreened	15/6 to 16/6
Household	23/6 to 25/-
Durham—	
Best Gas	19/-
Second	17/-
Household	23/6 to 25/-
Foundry Coke	21/-
Sheffield—	
Best Hand-picked Branch	30/- to 33/-
Barnsley Best Silkstone	26/- to 27/-
Derbyshire Best Brights	26/- to 28/6
,, ,, House	23/6 to 25/6
,, ,, Large Nuts	18/- to 22/-
,, ,, Small	14/- to 16/-
Yorkshire Hards	18/- to 22/-
Derbyshire ,,	18/6 to 22/-
Rough Slacks	10/- to 12/6
Nutty ,,	8/6 to 10/-
Smalls	3/- to 5/6
Blast-furnace Coke (Inland)*	—
,, ,, (Export)	f.o.b. 21/3 to 22/3

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	26/3 to 26/9
Second ,,	25/3 to 26/-
Best Dry Large	25/- to 25/6
Ordinary Dry Large	23/6 to 24/6
Best Black Vein Large	24/6 to 25/-
Western Valley ,,	23/6 to 24/6
Best Eastern Valley Large	23/- to 24/-
Ordinary ,, ,,	22/6 to 23/-
Best Steam Smalls	15/6 to 16/-
Ordinary ,,	13/- to 15/-
Washed Nuts	20/- to 27/6
No. 3 Rhondda Large	26/9 to 27/3
,, ,, Smalls	17/- to 18/-
No. 2 ,, Large	22/- to 23/-
,, ,, Through	18/- to 20/-
,, ,, Smalls	12/- to 13/6
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	25/- to 30/-
Patent Fuel	23/- to 26/-
Pitwood (ex ship)	23/- to 24/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	44/- to 46/-
Seconds	38/- to 40/-
Red Vein	29/- to 32/-
Machine-made Cobbles	52/6 to 57/6
Nuts	50/- to 55/-
Beans	37/6 to 41/6
Peas	21/6 to 23/6
Breaker Duff	8/3 to 8/9
Rubbly Culm	1 /- to 13/6
Steam Coals:	
Large	21/- to 24/-
Seconds	20/- to 21/-
Smalls	10/- to 13/-
Cargo Through	16/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/6, with fluctuations according to analysis; open market, 18/- to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Paris Fair.

THE transference of the annual Paris Fair from its former site on the Place des Invalides and the Champs de Mars to the newly laid out exhibition grounds near the Porte de Versailles is certain to contribute largely to the success of this gathering in the future. The importance of the Fair is growing every year, and the permanent Palais de l'Exposition was necessary for its development. The area of the grounds is about 10 acres. Only a few of the buildings are completed and much remains to be done before the grounds are in a finished state, but the two immense halls were amply sufficient for the exhibits of the electrical and engineering industries, while the grounds were almost entirely covered with halls and stands devoted to the entire range of French products. The Fair has become a thoroughly representative exhibition of French industry generally, and it may in the future develop a more pronounced international character. Following upon the decision last year to admit Belgian productions, the same privilege is now extended to other allied countries, with the result that in the engineering section there was quite a notable display of American machine tools and a few English machines, such as an axle turning lathe by Sir W. G. Armstrong, Whitworth and Co., Limited. Still, the foreign participation was relatively small, which may perhaps be attributed to makers abroad not being notified of the international character of the Fair; but, on the other hand, there would appear to be certain restrictions imposed upon foreign exhibits, for one firm had nothing on the stand except a notice to the effect that it was debarred from showing its particular specialities. The exhibition cannot become truly international if restrictions are imposed to keep out competitive goods.

Machine Tools.

One thing to be noted about the machine tool exhibits is that, while the French are covering this branch almost completely, they are still obviously feeling their way towards the final adoption of types of machines for which they will find a more ready sale. Except in the case of a very few firms it cannot be said that makers specialising in machine tools have experienced a profitable business. Many are known to have sustained losses, especially those who have been turning out the heavier machines, such as high-duty boring mills, slotters and planing machines. Soon after the Armistice there was a rush for such tools, but there has been practically no buying since then, and the only firms which appear to be doing anything are some of the Maubeuge concerns, which have the advantage of being able to produce cheaply in their reconstructed factories. The machine toolmakers in the Paris district are turning their attention to combination tools suitable for small shops. The period of slack buying through which the trade is now passing has compelled makers to offer machines for which special claims are made in the way of convenience and efficiency. The necessity of reducing production costs to a minimum has been so strongly impressed upon manufacturers that the field is certainly open to foreign machines which will perform particular duties under specially economical conditions. This is why American firms were amongst the first to profit from the publicity offered them by the Fair, and British makers would do well to take advantage of the same facilities, for it is certain that the Paris Fair is becoming of increasing importance every year as a mart for engineering tools and other equipments. It would be well, however, for intending exhibitors to make sure beforehand that they will be able to show their particular productions. There would probably be no trouble in the case of firms having agents in France.

A Commercial Clearing House.

There are certain British goods, outside engineering, which are being sold in France in successful competition with similar French manufactures, and such goods may even be bought at below the prices at which they are sold in England. In view of the exchange rate and the high import duties, as well as the freights for transport, the carrying on of a successful competition with French goods turned out under particularly economical conditions would appear to be incomprehensible. Nevertheless, it is being done by the simple expedient of sending to England consignments of such goods as perfumes, which can be sold at high prices and setting off against that amount the importation of a similar value of British goods. Even should there be a loss on the sale of the British goods, it would be more than covered by the profits on the French products sold in England. Whatever may be said about the economy of the arrangement, it at least ensures a market and provides employment in England. In the case of a number of firms combining to do business on these lines, the system would require an elaborate organisation and its success would be at the mercy of changes in fiscal policies. It is nevertheless based upon a rational interchange of goods, and, being successful in a small way, it may perhaps be worth while to investigate the possibility of developing it on a bigger scale.

New Paris Termini.

The Paris suburban traffic has developed so considerably of late years that some of the terminii are no longer able to deal with it satisfactorily, and several projects have been under consideration for enlarging some of the stations. In the case of the Gare St. Lazare, which has more suburban traffic than other stations, it was proposed either to construct platforms for the main lines on a level with the Cour de Rome, and therefore underneath the existing platforms, or to build a station for the arrival of the main line traffic at Rue Cardinet. After investigating these schemes the Conseil Supérieur des Travaux Publics rejects the Rue Cardinet proposal and recommends the construction of the low-level platform. This novel arrangement will necessitate the carrying out of some particularly interesting and extensive works. So far as concerns the Gare Montparnasse, the existing station is to be reserved for the submarine traffic and a new station is to be built in the Avenue du Maine for the main lines.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

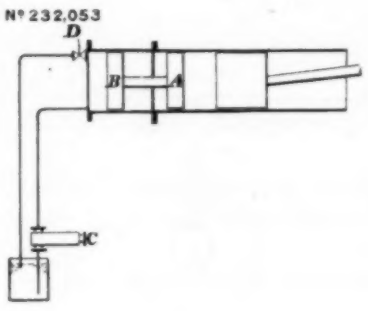
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

232,053. May 14th, 1924.—VARIABLE COMPRESSION, J. C. Fitzsimons, Castle-street, Kells, Co. Meath, Ireland.

The object of this invention is to vary the compression of the combustible charge according to the load on the engine. In the compression chamber there is a piston A connected with another piston B exterior to the cylinder. Behind the piston B a hydrostatic pressure is maintained by the pump C and the movement

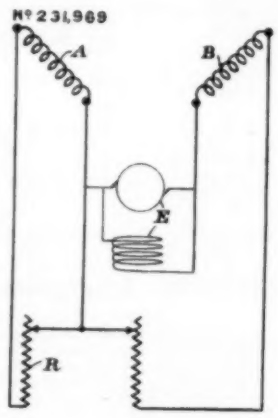


of the piston is controlled by the valve D in the return pipe of the pump circuit. This valve is connected with the governor of the engine in such a manner that when the engine is being started or is running slowly the piston A can move outwards and thus increase the capacity of the compression chamber, while when the engine is running this piston is pushed forward to reduce the space and the compression pressure is correspondingly increased.—*April 16th*, 1925.

DYNAMOS AND MOTORS.

231,969. January 28th, 1924.—IMPROVEMENTS IN SELF-STARTING SYNCHRONOUS MOTORS, Crompton and Co., Ltd., and Henry Ormsby Burge, both of Arc Works, Chelmsford, Essex.

The comparatively large exciting currents required by the machines of the induction synchronous type can be reduced by increasing the number of turns in the rotor, which, however, results in an excessive standstill voltage in the rotor. According to this invention the motor is wound with two separate windings A and B, which may be termed phases 1 and 2, and which are displaced 90 deg. from one another. These windings are connected as a two-phase three-wire system as shown, and the

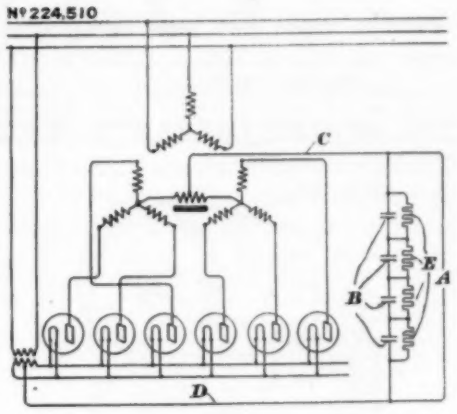


exciter E is permanently connected between the inner end of one of the phases and the neutral point. During the starting period the machine operates as an induction motor and the secondary operates as a two-phase three-wire winding. The two outer ends of the winding are connected to the two outer ends of the resistances R of a two-phase three-wire starter, and the neutral point of the secondary windings is connected to the neutral point of the starter. As the motor reaches feed speed the starting resistances are gradually short circuited and the exciter sends an exciting current through phase B, while phase A becomes short circuited on itself.—*April 16th*, 1925.

TELEGRAPHS AND TELEPHONES.

224,510. October 3rd, 1924.—IMPROVEMENTS IN SYSTEMS OF ELECTRIC DISTRIBUTION, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, W.C. 2.*

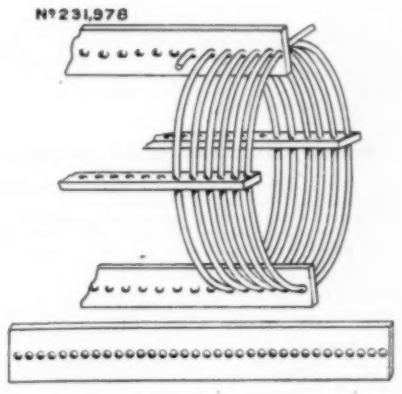
This invention relates more particularly to systems in which apparatus is supplied with high-voltage direct current by the rectification of alternating current. When rectifiers are employed which have a high internal resistance, such as high-vacuum thermionic rectifiers, there will be a considerable variation in the direct current voltage between no load and full load. When the load to be supplied fluctuates rapidly, as in the case of a wireless transmitter, the rapid changes from no load to full load and *vice versâ* may set up in the load apparatus transient voltages of much greater value than the voltage at which the apparatus is intended to operate. The presence of these transient voltages makes the design of the consumption apparatus a difficult problem, and it has been discovered that this difficulty may be overcome by permanently connecting a resistance load of comparatively small value across the direct-current supply circuit. When series condensers are connected across the direct current for smoothing out purposes the load resistance may also serve as a protective resistance or the condensers by subdividing the resistance and by making a section shunt each condenser. In the drawing six rectifying valves are shown, the load being connected at the point A. Series condensers are connected across



the loads C and D for smoothing out the rectified current, and resistances E are connected in shunt with these condensers.—*April 16th*, 1925.

231,978. February 6th, 1924.—METHODS OF SUPPORTING INDUCTANCE COILS AND THE LIKE, Frederick Henry Haynes, 5, Regent-square, W.C. 1.

The method of constructing inductance coils, according to this invention, will readily be understood from the accompanying

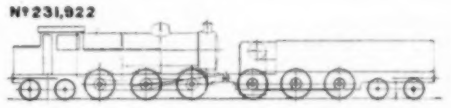


drawing. Rectangular pieces of insulating material with suitably spaced holes are employed, and through the holes wire spirals are threaded in the manner shown. The complete coil, the inventor states, can easily be provided with a pin and socket to enable coils of different inductances to be quickly inserted in a circuit.—*April 16th*, 1925.

LOCOMOTIVES.

231,922. December 11th, 1923.—TURBINE LOCOMOTIVES, Beyer, Peacock and Co., Ltd., and R. H. Whitelegg, Gorton Foundry, Manchester.

According to this specification it is proposed to use an ordinary steam locomotive in conjunction with another vehicle equipped

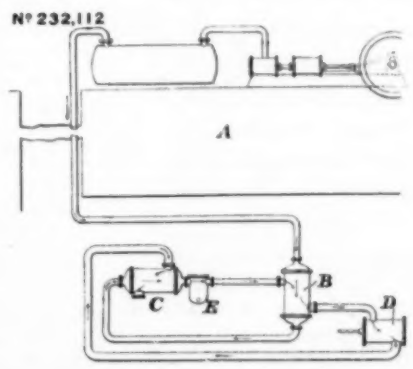


with a steam turbine and condenser. The steam exhausted by the reciprocating engine would be further expanded in the turbine driving the second vehicle, and then condensed in the condenser. The illustration needs no comment.—*April 14th*, 1925.

PUMPING AND BLOWING MACHINERY.

232,112. September 24th, 1924.—DRYING COMPRESSED AIR, J. N. D. Heenan, Aldwych House, Aldwych, London, W.C. 2.

This invention is intended to prevent the freezing up of engines



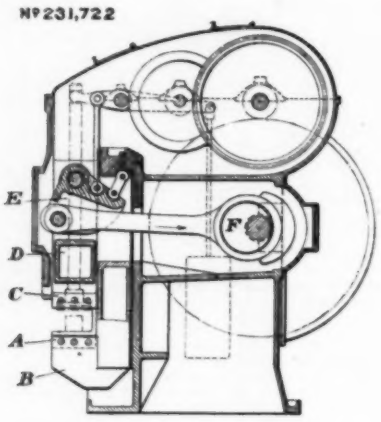
worked by compressed air. The moist air coming from the compressor A is passed through a heat interchanger B and then through another interchanger C, which is cooled by the exhaust

from the engine D. The cooling of the air precipitates the contained moisture, which is extracted at E. The air then goes on to the first interchanger B and is re-heated before being admitted to the engine.—*April 16th*, 1925.

MACHINE TOOLS AND SHOP APPLIANCES.

231,722. July 21st, 1924.—SHEARING MACHINES, *H. A. Gill*, 51–52, *Chancery-lane, London, W.C.* 2.

In this shearing machine both the top and bottom blades are movable and slide vertically in the main frame. The bottom blade A is held in the hook-shaped slide B, while the top blade C is carried by the slide D. The bell-crank E is pivoted to the

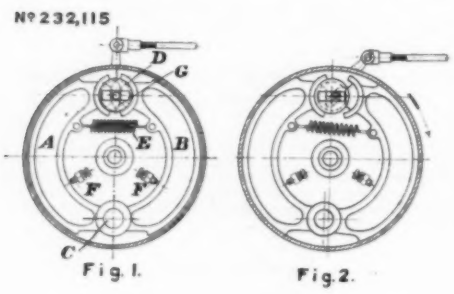


two slides, as shown, and is operated by the excentric F. In working, the top slide first comes down until its blade meets the piece to be cut, and then the bottom blade is pulled up, by the bell crank, to do the shearing. The arrangement has the advantage that the main frame is not subjected to tensional or bending stresses.—*April 9th*, 1925.

MOTOR CARS AND ROAD TRAFFIC.

232,115. September 27th, 1924.—EXPANDING BRAKES, G. Fornaca, 7 via Giannone, Turin, Italy.

The object of this invention is to use the momentum of the vehicle to apply the brakes. The two brake shoes A B are pivoted together at C and are held up against a stop D by the

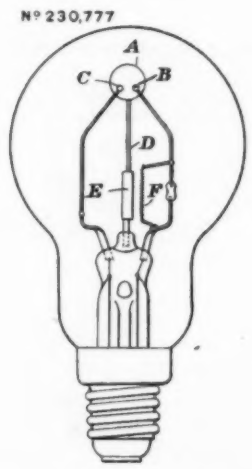


spring E. F F are steadies. If the upper ends of the shoes are pushed apart by means of the cam G and the wheel is rotating clockwise the parts will take up the position shown in Fig. 2, in which case it will be seen the shoe B acts to force the shoe A against the brake drum and produce a very powerful braking effect. The brake is reversible.—*April 16th*, 1925.

LIGHTING AND HEATING.

230,777. August 9th, 1924.—IMPROVEMENTS IN TUNGSTEN LAMPS, *The General Electric Company, of Magnet House, Kingsway, W.C.* 2.

This specification describes an arc lamp suitable for working on an alternating-current supply. The disc shown at A in the drawing is composed of a mixture of tungsten and thorium oxide, and to facilitate starting it may be coated with an alkaline earth material, suitably prepared by the decomposition of barium

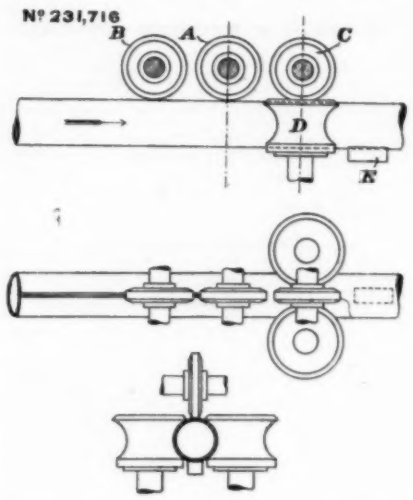


oxide. When the lamp is not in operation the disc lies against the electrodes B and C and bridges the gap between them. In the stem D carrying the disc is a bi-metallic strip E, which, when the current is switched on, is heated by a resistance wire F and the bi-metallic strip E draws the disc away from the electrodes. An arc is then struck between the electrode B and the disc A, the electrode B becoming white hot, whilst the remaining electrode C attains a red heat. When this second electrode moves away from the disc C the arc strikes across the second electrode, and when the current is switched off the disc A returns to its initial position.—*April 16th*, 1925.

WELDING.

231,716. June 27th, 1924.—ELECTRICALLY WELDING PIPES, J. Harmatta, III., Római fürdö, Budapest, Hungary.

This process is intended for electrically butt welding pipes of a diameter so small that an internal roller electrode cannot be used. Current is supplied to the roller A, and may also be supplied to the auxiliary roller B, and flows along the welding

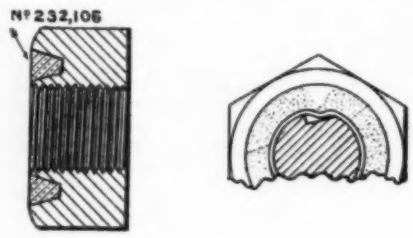


edges of the pipe to the roller C, the squeezing rolls D and the sliding contact E, all these four parts being connected to one pole of the circuit. The tube is fed into the machine in the direction of the arrow. It is said that by adjusting the various rollers the point of greatest heating can be moved longitudinally.—*April 9th*, 1925.

MISCELLANEOUS.

232,106. September 8th, 1924.—LOCK NUTS, R. M. G. Sobey, 127, Wellington-street, Windsor, Victoria.

In this lock nut an annular groove is cut in the face so as to leave a thin projection round the thread as shown. An angular groove is cut in the bolt and the thin projection is punched into



this groove when the nut has been tightened. The groove in the bolt is of such a form that the nut can be tightened further, but will not slack back. The annular groove in the nut may be filled with some composition to prevent the lodgment of water and the consequent corrosion.—*April 16th*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

DIESEL ENGINE USERS' ASSOCIATION.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Pyrometry of Exhaust Temperatures of Internal Combustion Engines," by Mr. Charles E. Foster. 3.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Extra general meeting. "Some Tests on a Two-stroke Cycle Oil Engine," by Professor E. A. Allcut. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Connaught Rooms, Great Queen-street, London, W.C. 1. Metropolitan District meeting. 4 p.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, London, S.W. 7. Lecture, "The Intensity of Spectral Lines—Measurement and Theory," by Professor L. S. Ornstein. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Metabolism of Man and Animals," by Dr. T. M. Carpenter. 9 p.m.

SATURDAY, MAY 23RD.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Students' visit to Birmingham, Tame and Rea District Drainage Board Works. 2.15 p.m.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Visit to the works of the Ford Motor Company, Ltd., Trafford Park, Manchester. 2.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting at Darlington. 10.45 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Shire Hall, Nottingham. East Midland District meeting. 3 p.m.

MONDAY, MAY 25TH.

SOCIETY OF GLASS TECHNOLOGY.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Symposium of papers on "The Constitution of Glass." 7.30 p.m.

TUESDAY, MAY 26TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Passage of Electricity Through Vacuum Tubes, II.," by Professor R. Whiddington. 5.15 p.m.

SOCIETY OF GLASS TECHNOLOGY.—Chemistry Lecture Theatre, University College, Gower-street, London, W.C. 1. Continuation of symposium on "The Constitution of Glass." 2.30 p.m. Annual Dinner at the Hotel Cecil, Strand, London, W.C. 2. 7.15 p.m.

FRIDAY, MAY 29TH.

CHEMICAL ENGINEERING GROUP.—Chemical Industry Club, 2, Whitehall-court, London, S.W. 1. Sixth annual general meeting. 8.15 p.m. To be preceded by an informal dinner at 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Scenery in the Pastoral Poets," by Sir Henry Newbolt. 9 p.m.

WEDNESDAY, JUNE 3RD.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "The Effect of Wave Damping in Radio Direction Finding," by Dr. R. L. Smith-Rose. 6 p.m.

THURSDAY TO SATURDAY, JUNE 4TH TO 6TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Meeting in Scottish District at Dumfries.

SATURDAY, JUNE 6TH.

INSTITUTION OF ENGINEERS-IN-CHARGE.—Visit to Bushey House, Teddington. 2.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District meeting at Reading. 11 a.m.

TUESDAY TO FRIDAY, JUNE 9TH TO 12TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer meeting at Birmingham and District. For programme, see page 380.

INSTITUTION OF GAS ENGINEERS.—Annual general meeting in London. For programme, see page 414.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE SELSON ENGINEERING COMPANY, Ltd., asks us to announce that it has removed to Selson Buildings, 26 and 28, Charles-street, London, E.C. 1. Telephone: Holborn 2921; telegraphic address: Selsoneer, Smith, London.

As for many years past, the fire protection arrangements of the Bath and West and Southern Counties Agricultural Show, which opens at Maidstone on May 28th, will again be entrusted to Merryweather and Sons, Ltd. A detachment of the Merryweather Fire Brigade will be on duty day and night throughout the Show.

WE understand that Mr. K. S. Murray, M.I. Mech. E., who has been for many years the managing director of the British Oxygen Company, has been elected to the chairmanship of that company, which has been rendered vacant by the death of Mr. E. B. Ellice Clark, M. Inst. C.E. Mr. Murray will for the present continue also to discharge the duties of managing director.

CONTRACTS.

VICKERS Ltd. announce that they have received an official order from the Australian Government for two submarines, and that they have also been instructed to proceed with the construction of the gun mountings for one of the two cruisers building in this country.

THE BRIGHTSIDE FOUNDRY AND ENGINEERING COMPANY, Ltd., of Sheffield, has received an order for a hydraulic decking installation from the Carlton Main Colliery Company, Ltd. The plant is for handling 12 tubs per wind at both the top and bottom terminals.

HOWDEN-LJUNGSTROM PREHEATERS (LAND), Ltd., has received an order to supply a preheater to John Galloway and Co., Ltd., Balerno Mills, Balerno, near Edinburgh. The total heating surface of the preheater is to be 26,700 square feet, and air will be supplied to the furnace at about 570 deg. Fah.

WILLIAM BOBY AND CO., Ltd., of Brookfield House, 62 and 64, Brook-street, Hanover-square, London, W. 1, have received an order from the Metropolitan Asylums Board for the Grove Park Institution for one of its "Azed" water softeners, having a capacity of 20,000 gallons of water softened between regenerations.

ALL the internal and external surfaces of the pontoons and the girders of the new ferries stage, which has recently been placed in position at Seacombe, Cheshire, and which is over 480ft. in length, were coated with the "Bitumastic" solution and enamel of Wailes Dove Bitumastic, Ltd., of Newcastle-on-Tyne.

THE Underground Railways have now placed contracts with the Foundation Company, Limited, for the driving of escalator tunnels at South Wimbledon and Collier's Wood Stations on the new Morden Line extension. These contracts amount to nearly £50,000. It is expected that the Morden Line will be ready for traffic early next year.

THE "D.P." BATTERY COMPANY, Ltd., of Bakewell, Derbyshire, has just secured an order from the Aberdeen Corporation Electricity Department for re plating the Ferryhill generating station battery. The order is for the company's standard heavy central station type plates, and the battery is to have a capacity of 2904 ampère-hours.

IT is announced that Sir W. G. Armstrong, Whitworth and Co., Ltd., have secured a contract from the Mersey Docks and Harbour Board for the supply and erection of three pairs of steel gates for the river entrance of the Alfred Dock at Birkenhead, which has a width of 80ft. The work is to be completed within a period of twenty-two months.

J. DAMPNEY AND CO., Ltd., inform us that at the Barking Power Station of the County of London Electric Supply Company, Ltd., over 3000 tons of steel work have been coated with their special protective paint, and also that the five Yarrow boilers and five Babcock and Wilcox boilers have been treated internally with their "Apexior" compound.